ELECTRONICS SYSTEMS DIVISION RAVEN industries, inc.

Interim Report

SKYHOOK CHURCHILL 1972

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Arlington, Virginia 22217

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Table of Contents

Section			Page
	Abstract		
I.	Introduction		1
II.	Program Description		2
	A. Operational		2
III.	Flight Description		19
	A. Fort Churchill Program		19
1319		NASA-Goddard Space Flight Center Dr. T. Cline	20
1320		NASA-Goddard Space Flight Center Dr. Ormes	23
1321		NASA-Goddard Space Flight Center Dr. R. Hartman/J.K. Daugherty	30
1325		NASA-Goddard Space Flight Center Dr. R. Hartman	36
1328		NASA-Goddard Space Flight Center Dr. R. Hartman	43
1322		Naval Research Laboratory Dr. M.M. Shapiro/H. O'Dell	49
1329		University of California-Riverside Dr. R. White	54
1331		Louisiana State University Dr. S. Verma	60
1324		University of New Hampshire Dr. W. Webber/B. Evans	66
1326		University of New Hampshire Dr. W. Webber	70
1327		University of New Hampshire Dr. W. Webber	74

Section		Page
1323	University of Chicago Dr. P. Meyer/G. Fulks	77
1333	University of Chicago Dr. P. Meyer/G. Fulks	83
1334	University of Chicago Dr. P. Meyer/G. Fulks	87
1330	University of Maryland Dr. J. Earl/J. Luhmann/L. Bagg	90
1332	University of Maryland Dr. J. Earl/L. Bagg/Dr. O'Gallagher/ H. Leach	96
1335	University of Maryland/Univ. of Calgary Dr. Earl/Lueman/O'Gallagher/Leach/Bland	100
B.	Cape Girardeau, Missouri Program	104
1336	University of New Hampshire Professor John Webber Rice University Dr. Hugh Anderson Atomic Energy Commission Peter Raft	108
1337	Washington University Dr. M. Israel/Dr. J. Klarmann	111
1338	University of Chicago Professor Peter Meyer/Inar Juliusson	117
1339	University of California-Riverside Professor Stephan White	122
1340	University of Chicago Professor Peter Meyer/Inar Juliusson	126
1341	Goddard Space Flight Center Dr. Ormes	129
C.	Red Deer, Alberta Program	133

Section

		Page
1342	NASA-Goddard Space Flight Center Dr. D.V. Reames	136
1343	NASA-Goddard Space Flight Center Dr. R.C. Hartman	142
1344	NASA-Goddard Space Flight Center Dr. R. Hartman	146
IV.	Parachute Failure Analysis	151
V.	Distribution	156

Tables

1.	Chronological Times of Launch	5
2.	Flight Summary Table	7
3.	Hitchhike Experiments	9
4.	Utilization of Field Time	9
5.	Skyhook Administrative and Operational Organization	10
6.	Skyhook Scientific Program Personnel - Churchill Program	11
7.	Skyhook Scientific Program Personnel - Cape Girardeau Program	13
8.	Skyhook Scientific Program Personnel - Red Deer Program	14
9.	Aircraft Flight Time Usage	15
10.	Radio Frequency Usage - 1972	16

Figures

1.	Flight Summary Map	7
2.	Flight 1319 Time-Altitude Curve	22
3.	Flight 1320 Time-Altitude Curve	28
4.	Flights 1321, 1325, 1328 Trajectory Map	29
5.	Flight 1325 Time-Altitude Curve	42
6.	Flight 1328 Time-Altitude Curve	47
7.	Flights 1322, 1329, 1331 Trajectory Map	48
8.	Flight 1322 Time-Altitude Curve	53
9.	Flight 1329 Time-Altitude Curve	59
10.	Flight 1331 Time-Altitude Curve	65
11.	Flight 1324 Time-Altitude Curve	69
12.	Flights 1324 & 1327 Trajectory Map	73
13.	Flight 1327 Time-Altitude Curve	76
14.	Flight 1323 Time-Altitude Curve	81
15.	Flights 1323, 1333, 1334 Trajectory Map	82
16.	Flight 1333 Time-Altitude Curve	86

Section Page

Figures (Cont.)

17. Flight 1334 Time-Altitude Curve 89
18. Flight 1330 Time-Altitude Curve 95
19. Flight 1332 Time-Altitude Curve 98
20. Flights 1330, 1332, 1335 Trajectory Map 99
21. Flight 1335 Time-Altitude Curve 103
22. Flight 1336 Time-Altitude Curve 110
23. Flight 1337 Time-Altitude Curve 116
24. Flight 1338 Time-Altitude Curve 121
25. Flight 1339 Time-Altitude Curve 125
26. Flight 1340 Time-Altitude Curve 128
27. Flight 1341 Time-Altitude Curve 132
28. Flight 1344 Time-Altitude Curve 150

Maps

1. Cape Girardeau Impact Map No. 1 106
2. Cape Girardeau Impact Map No. 1 107
3. Red Deer Impact Map 135

ABSTRACT

The 1972 Skyhook contract, N00014-72-C-0400, dated 3 April 1972, was awarded to Raven Industries, Inc. to perform the field operations for the Fort Churchill, Canada scientific expedition. Balloons were provided by Winzen Research, Inc. of Minneapolis, Minnesota.

Two flights were performed in May of 1972 under Contract N00014-71-C-0295 for Goddard Space Flight Center from Sioux Falls. Flight Descriptions for these flights are included in this report. At Fort Churchill, fifteen flights were attempted with one launch abort. Another six flights were flown from Cape Girardeau, Missouri, and three flights from Red Deer, Alberta, with the latter having two launch aborts.

In performance of the 1972 contract, Raven Industries provided the following personnel and equipment:

1. A crew of eighteen men to conduct launch, tracking, recovery, and instrumentation tasks.

2. Suspension hardware, rigging, crush pads, etc.

3. Fixed-wing and helicopter tracking and recovery aircraft.

4. Experimental "L Band" transmitter and ground station in preparation for the "switch-over" in 1973.

5. Interim and final reports to include documentation of balloons, instrumentation, and operational performance.

Each flight is described in detail under the Flight Description section of this report. Other significant information is presented in tables listed throughout the report.

I. INTRODUCTION

Skyhook 1972 was the 14th consecutive field operation conducted at Fort Churchill under the auspices of the Office of Naval Research. The program began in 1959 with only five flights, with as many as thirty-two flights being flown in subsequent years.

Churchill was originally selected as a balloon launch site because of its nearness to the geomagnetic pole, availability of housing and messing facilities, rail, and air service. The large airport runways, ramp area, and hangars made it particularly suitable to launching balloons.

Skyhook 1972 officially began on 22 June, with the arrival of two Raven personnel who were sent up to unload equipment and set up the site. An operation of the magnitude of Skyhook 1972 requires considerable support from the Churchill Research Range. Raven Industries, Inc. and the Office of Naval Research are deeply indebted to the Range Management and staff for their continued cooperation and assistance. Special appreciation is given to Mr. Paddy Faulkner, General Superintendent; Mr. Patrick Worth, Range Operations Office; Mr. Roy Hepner, National Research Council; Mr. Phillip Nicholas, D.O.T. Airport Manager; Mr. Bill Cooper, Lamb Air Ltd.; and Mr. Barry Wetter, Pan American Meteorologist.

During the Red Deer Program, upper wind data was obtained from radar tracking of corner reflectors carried aloft on 4275 gram balloons. Tracking was performed by Canadian forces radar personnel, under the direction of Major Brasseaur.

II. PROGRAM DESCRIPTION

A. Operational

Skyhook 1972 consisted of four separate launch sites: Fort Churchill, Manitoba, with fourteen launches; Red Deer, Alberta, one launch; Cape Girardeau, Missouri, six launches; and two from Sioux Falls, South Dakota.

Nine separate scientific groups participated in the Churchill phase of the program: University of Chicago, University of New Hampshire, University of Maryland, University of California-Riverside, Louisiana State University, NASA-Goddard, Naval Research Laboratory, University of Calgary, and the University of Rice, Houston.

Both launch and recovery crews were ready to operate by the 28th of June. New quarters were provided for the launch crew in the small hangar once occupied by Lamb Air Ltd. The hangar was suitable from a building standpoint, however, its location made it necessary to cross the main runway to reach the launch area. Shop space was less than in previous quarters in Q-37. Sufficient space, however, was available in the hangar for storage of all balloons with space left to park the launch truck.

The Uranium City Tracking Center was set up in the permanent building provided by the Office of Naval Research since 1969. The Center is located on a hill used by the Sasketchewan Telephone Company for a Telephone Relay Station. Previous to 1969, the Center was located in the Hotel at Uranium City; a location which had a high noise level and considerable interference with obstructions which greatly reduced the tracking range of the Center. The new location allows both Churchill and Uranium City to track a balloon simultaneously for several hundred miles. The site requires about 48 hours to activate once the equipment is delivered from Churchill in the C-47.

Scientific groups were provided shop space in the technical support building or in the motor pool, which could accommodate the larger gondolas. When experiments became ready for flight, the gondolas

were transported to the operation's hangar; weighed, rigged, and suspended on one of two launch trucks, which was than driven to the launch site.

In previous years of operation at Fort Churchill, launches could be made from any place on the parking ramp, however, with the large balloons in routine use today, available space in the ramp area is diminishing. Certain permanent modifications to the large runway require traffic to proceed through the ramp area, therefore, the ramp area has become less suitable as a launch site, especially for the bigger balloons.

Balloons launched from Fort Churchill are normally launched from one of two launch trucks, depending on size and length of the scientific gondola. Maximum inflation is limited to 5500 pounds, primarily due to the weight of the launch vehicles.

Experiments which weigh over 1000 pounds and cannot be disassembled into smaller, manageable units are usually not flown from Churchill. During the 1972 Program, one flight, No. 1329, was flown which exceeded the lifting capacity of the helicopter.

Two launch spools are usually available at Churchill. The smaller spool is used for the balloons up to 10 million cubic feet, while the larger spool is used on the larger balloons.

On the average, a Churchill flight has a duration of sixteen to twenty hours. The duration is determined by the time required to reach the recovery area which is the west end of Lake Athabaska, the Slave River to the north, and the Athabaska River to the south.

A typical flight released from Churchill will assume an easterly to southeasterly trajectory often reaching 60,000 feet before turning to the west. On occasion, a flight will reach ceiling directly over the launch site which increases the overall trajectory and often the time at ceiling.

Electronic tracking is accurate out to 375 miles from either station. During multiple flights, tracking beyond 150 miles from Churchill is normally

turned over to the Uranium City Station, which coordinates flight termination with ATC Edmonton and tracking aircraft.

Recovery is often performed by all three aircraft simultaneously, or by the C-47 alone, or jointly by the 206 float plane and helicopter. The 206 float plane and helicopter act as a team. The helicopter provides the lifting capability, while the 206 Cessna provides transportation for the ground clearing crew, extra fuel for the helicopter, as well as a means for recovery of smaller items from the scientific gondolas, such as control instruments, parachutes, timers, etc.

The C-47 provided by the Office of Naval Research and operated by Raven, is primarily a logistics support aircraft, however, with its speed and range, it is well suited for tracking as well. In addition to its cargo capability, the "Goonybird" serves as an aerial command post during multiple flights or when descents of one or more scientific gondolas are separated by a considerable distance. The C-47, as is typical the world over, is very practical for the Skyhook operation, however, in recent years the scientific gondolas are becoming too large and often cannot be dismantled into smaller units which permit loading aboard the C-47.

The three aircraft provide an adequate team with a capability of having a scientific gondola recovered and back to the scientist within 30 hours from launch.

Optimum utilization of all possible balloon launching days is important. Generally scientific groups arrive several days prior to the Raven crew.

Flights are scheduled on a basis of availability. The first experiment ready will be launched first. The need for priorities has not existed for several years. On occasion, due to peculiarities of the experiment or flight train or scientist, special priorities have been set up. In cases where scientific groups have several flights to be flown,

these groups will take priority over groups with single flights.

Flights aloft have priority over flights on stand-by or in the process of being laid out. Likewise, a balloon on ascent has priority over a flight at ceiling. Balloons which are in descent have priority over all other flights.

Table 1 presents a chronological summary of the various flights flown in 1972, as well as the particular flight number and scientific group. The large fold-out, Table 2, provides all pertinent information on each flight. It is a ready reference on balloons, load and suspension details, amount of helium used, float altitudes, etc. Hitchhike packages listed in Table 3 were flown on flights indicated.

Table 1

Chronological Times of Launch

	Time (Z)		Flight No.	Group
A.	Sioux Falls			
	1350	4 May	1319	Goddard Space Flight Center
	1305	16 May	1320	Goddard Space Flight Center
B.	Fort Churchill			
	0123	2 July	1322	Naval Research Laboratory
	0400	3 July	1321	Goddard Space Flight Center
	0856	4 July	1324	Univ. of New Hampshire
	0056	6 July	1325	Goddard Space Flight Center
	0150	7 July	1326	Univ. of New Hampshire
	1331	14 July	1327	Univ. of New Hampshire
	0051	19 July	1328	Goddard Space Flight Center
	0000	21 July	1323	Univ. of Chicago
	2159	21 July	1330	Univ. of Maryland

Time (Z)		Flight No.	Group
1153	22 July	1329	Univ. of California
2327	24 July	1331	Louisiana State Univ.
0057	25 July	1333	Univ. of Chicago
1322	26 July	1332	Univ. of Maryland
1447	27 July	1334	Univ. of Chicago
2032	29 July	1335	Univ. of Maryland/Univ. of Calgary
0705	11 Sept.	1336	Univ. of New Hampshire
0134	13 Sept.	1337	Washington University
0354	14 Sept.	1338	Univ. of Chicago
0912	19 Sept.	1339	Univ. of California
0741	28 Sept.	1340	Univ. of Chicago
1414	1 Oct.	1341	Goddard Space Flight Center

C. Red Deer

1355	20 Oct.	1342	Goddard Space Flight Center
0702	27 Oct.	1343	Goddard Space Flight Center
1427	31 Oct.	1344	Goddard Space Flight Center

			ALTITUDE							
			DURATION		THEORETICAL - ①		MEASURED TRANSDUCER			
					WITH	WITHOUT				
DATE	FLT. NO.	SCIENTIST & GROUP	TOTAL	CEILING	BALLAST	BALLAST	MAX	MIN	TERM	WT.
4 MAY	1319	CLINE - GSFC	29:55	2o:22	4.1	3.5	2.8	5.5	4.0	
16 MAY	1320	ORMES - GSFC	4:23	-	2.93	2.60	4.1	-	4.1	3(
3 JULY	1321	HARTMAN - GSFC	1:11	-	2.82	2.38	231.0	-	36.0	1(
2 JULY	1322	SHAPIRO/O'DELL - NRL	15:27	10:25	1.81	1.56	1.55	1.6	1.7	1(
21 JULY	1323	MEYER/FULKS - U OF CHICAGO	19:36	15:18	2.36	1.97	1.8	2.45	1.7	1(
4 JULY	1324	WEBBER - U OF N. HAMPSHIRE	18:06	14:42	3.19	2.76	2.5	2.9	2.6	1(
6 JULY	1325	HARTMAN - GSFC	16:24	11:59	2.39	1.97	1.4	1.5	1.9	2(
7 JULY	1326	WEBBER - U OF N. HAMPSHIRE	LAUNCH ABORT			-	-	-	-	1(
14 JULY	1327	WEBBER - U OF N. HAMPSHIRE	15:23	12:25	3.59	2.94	2.9	3.5	3.0	1(
19 JULY	1328	HARTMAN - GSFC	18:35	13:24	3.04	2.57	2.0	2.4	2.2	1(
22 JULY	1329	WHITE - U OF CALIFORNIA	23:10	19:24	3.65	3.31	3.3	4.5	3.5	1(
21 JULY	1330	EARL - U OF MARYLAND	23:09	19:15	3.54	3.11	3.2	3.3	3.2	1(
24 JULY	1331	VERMA - LSU	17:35	13:54	3.07	2.7[illegible]	2.6	2.8	2.7	1(
26 JULY	1332	EARL - U OF MARYLAND	20:33	17:26	3.56	3.16	3.2	5.5	3.8	1(
25 JULY	1333	MEYER/FULKS-U OF CHICAGO	17:54	13:29	2.36	1.97	1.8	2.4	1.8	1(
27 JULY	1334	MEYER/FULKS-U OF CHICAGO	15:3[illegible]	12:25	2.32	1.94	TRANSDUCER		FAILED	1(
29 JULY	1335	EARL/BLAND-U OF MD. & CALGERY	20:17	16:27	2.99	2.66	2.8	6.2	5.5	1(
11 SEPT	1336	WEBBER - U OF N. HAMPSHIRE	17:40	13:23	2.8	2.44	2.7	3.5	3.7	1(
13 SEPT	1337	KLARMANN/SREAL - WASH. UNIV.	22:40	18:51	3.1	2.73	3.5	4.2	3.7	1(
14 SEPT	1338	MEYER/JULIUSSON - U OF CHICAGO	40:53	36:34	4.5	3.75	4.6	7.8	5.0	1(
19 SEPT	1339	WHITE - U OF CALIFORNIA	29:50	26:33	3.55	3.05	3.6	8.4	4.0	1(
28 SEPT	1340	MEYER/JULIUSSON - U OF CHICAGO	39:04	34:13	4.25	3.55	4.0	10.0	5.8	1(
1 OCT	1341	ORMES - GSFC	26:26	22:29	3.0	2.75	3.0	4.4	3.0	3(
20 OCT	1342	REAMES - GSFC	LAUNCH ABORT			-	-	-	-	1(
27 OCT	1343	HARTMAN - GSFC	LAUNCH ABORT			-	-	-	-	2(
31 OCT	1344	HARTMAN - GSFC	8:22	4:55	8.50	8.2	8.0	8.9	8.2	2(

	BALLOON					HELIUM				EQUIPMENT				
	MATERIAL THICKNESS													
WT. LBS	SHELL	CAP	VOL.	R/S	S.N.	CUBIC FEET	FREE LIFT	%	GROSS LIFT	GROSS LOAD	SUSP. LOAD	EXP. WT.	RAVEN WT.	TOT LE
357	0.5	-	2.94		324	15624	108	12	1008	900	543	282	369	15
3647	0.9	2 - 0.9	33.1	X	1	122927	721	10	7934	7213	3566	2502	1064	75
1910	0.6	2 - 0.6	18.5	X	10	59582	472	14	3844	3372	1462	800	662	50
1245	0.5	2 - 0.5	15.0	X	30	31775	236	13	2050	1814	569	190	379	25
1256	0.5	2 - 0.5	15.0	X	29	40207	319	14	2594	2275	1019	532	487	35
1284	0.7	0.7	10.575	X	412	38796	307	14	2503	2196	912	467	445	30
2576	0.6	2 - 0.7	30.5		5	73144	580	14	4719	4139	1563	800	763	60
1268	0.7	0.7	10.575	X	413	42051	333	14	2713	2380	1112	667	445	30
1273	0.7	0.7	10.575	X	411	43756	347	14	2823	2476	1203	707	496	35
1858	0.6	2 - 0.6	18.5	X	6	58760	466	14	3791	3325	1471	807	664	50
1689	0.6	2 - 0.6	15.0	X	31	64650	512	14	4171	3659	1970	1370	600	40
1488	0.7	0.9	11.6	X	3	49398	391	14	3187	2796	1308	795	513	35
1031	0.5	0.7	10.575	X	414	36828	292	14	2376	2084	1053	693	360	20
1519	0.7	0.9	11.6	X	4	50142	397	14	3235	2838	1319	807	512	35
1296	0.5	2 - 0.5	15.0	X	28	40904	324	14	2639	2315	1019	532	487	35
1248	0.5	2 - 0.5	15.0	X	27	40176	318	14	2592	2274	1026	543	483	35
1074	0.5	0.7	10.6		159	36130	321	16	2331	2010	936	595	341	22
1442	0.7	0.9	11.6	X	5	41617	330	14	2685	2355	913	462	451	30
1648	0.6	2 - 0.6	15.0	X	36	65410	518	14	4220	3702	2054	1380	674	51
1975	0.7	2 - 0.7	15.0	X	22	85947	681	14	5545	4864	2889	1655	1234	100
1598	0.6	2 - 0.6	15.0	X	35	67177	532	14	4334	3802	2204	1430	774	60
1879	0.7	2 - 0.7	15.0	X	34	82646	655	14	5332	4677	2798	1604	1194	90
3789	0.9	2 - 0.9	33.1	X	2	128820	890	12	8311	7421	3632	2552	1080	70
1877	0.6	2 - 0.6	18.5	X	8	62294	494	14	4019	3525	1648	1192	456	25
2925	1.5	1.5	10.5	X	5	134943	933	12	8706	7773	4848	3866	982	60
2894	1.5	1.5	10.5	X	4	128696	755	10	8303	7548	4654	3866	788	40

LOAD & SUSPENSION

VEN T.	BALLAST TOTAL LBS	BALLAST TOTAL EXP	BALLAST %	PARACHUTE MFG	PARACHUTE SIZE	PARACHUTE TYPE	PARACHUTE WT.	PARACHUTE SR. NO.	DESCENT ALT.	DESCENT WT.	DESCENT TIME	DESCENT RATE
69	150	150	16.6	SMITH	38	F/C	42	182	123.0	393	48	20
64	750	750	10.4	NORP	84.2	R/S	127	6	122.0	2816	31	24
62	500	500	14.8	RADIO	67	E/S	89	10	36.0	962	21	18
79	250	250	13.8	PIONEER	32	F/C	32	487052	152.8	319	39	21
87	350	350	15.4	UNK	49	E/G	57	9-4046-6	146.0	669	38	20
45	300	300	13.7	UNK	49	E/G	53	9-4046-4	137.0	612	34	19
63	600	550	14.5	RADIO	67	E/S	89	8	150.0	963	51	18
45	300	300	12.6	UNK	49	E/G	54	9-4046-4	LAUNCH		ABORT	-
96	350	350	14.0	UNK	49	E/G	53	9-4046-4	134.5	853	35	23
64	500	500	15.0	RADIO	67	E/S	86	8	143.0	971	47	18
00	400	400	10.9	PIONEER	70	F/C	92	461358	132.0	1370	33	20
13	350	350	12.5	RADIO	67	E/S	92		133.0	958	53	18
60	200	200	9.6	PIONEER	48	F/C	53	473309	136.0	853	37	23
12	350	350	12.3	RADIO	67	E/S	92		129.0	969	45	18
87	350	350	15.2	UNK	49	E/G	57	9-4046-6	148.0	669	51	20
83	350	350	15.4	UNK	49	E/G	53	9-4046-4	-	676	42	20
41	225	225	11.2	PIONEER	46.5	E/G	48	499845	118.0	711	42	21
51	300	300	12.7	UNK	49	E/G	53	9-4046-2	127.0	613	44	19
74	513	513	13.8	PIONEER	70	F/C	87	461358	126.5	1541	49	21
34	1000	1000	20.6	RADIO	67	E/G	120	23902	119.0	1869	38	24
74	600	600	15.8	PIONEER	64	F/C	67	454912	124.0	1604	14	FREE FALL
94	900	900	19.2	RADIO	67	E/G	110	1	115.0	1898	32	24
80	700	900	9.4	PIONEER	100	F/C	147	487146	130.0	2932	41	20
56	250	250	7.1	RADIO	67	E/G	67	1	LAUNCH		ABORT	-
82	600	0	7.7	PIONEER	100	F/C	250	487147	LAUNCH		ABORT	-
88	400	400	5.3	PIONEER	100	F/C	250	487147	106.0	4254	27	25

1972 CHURCHILL IMPACT SUMMARY MAP

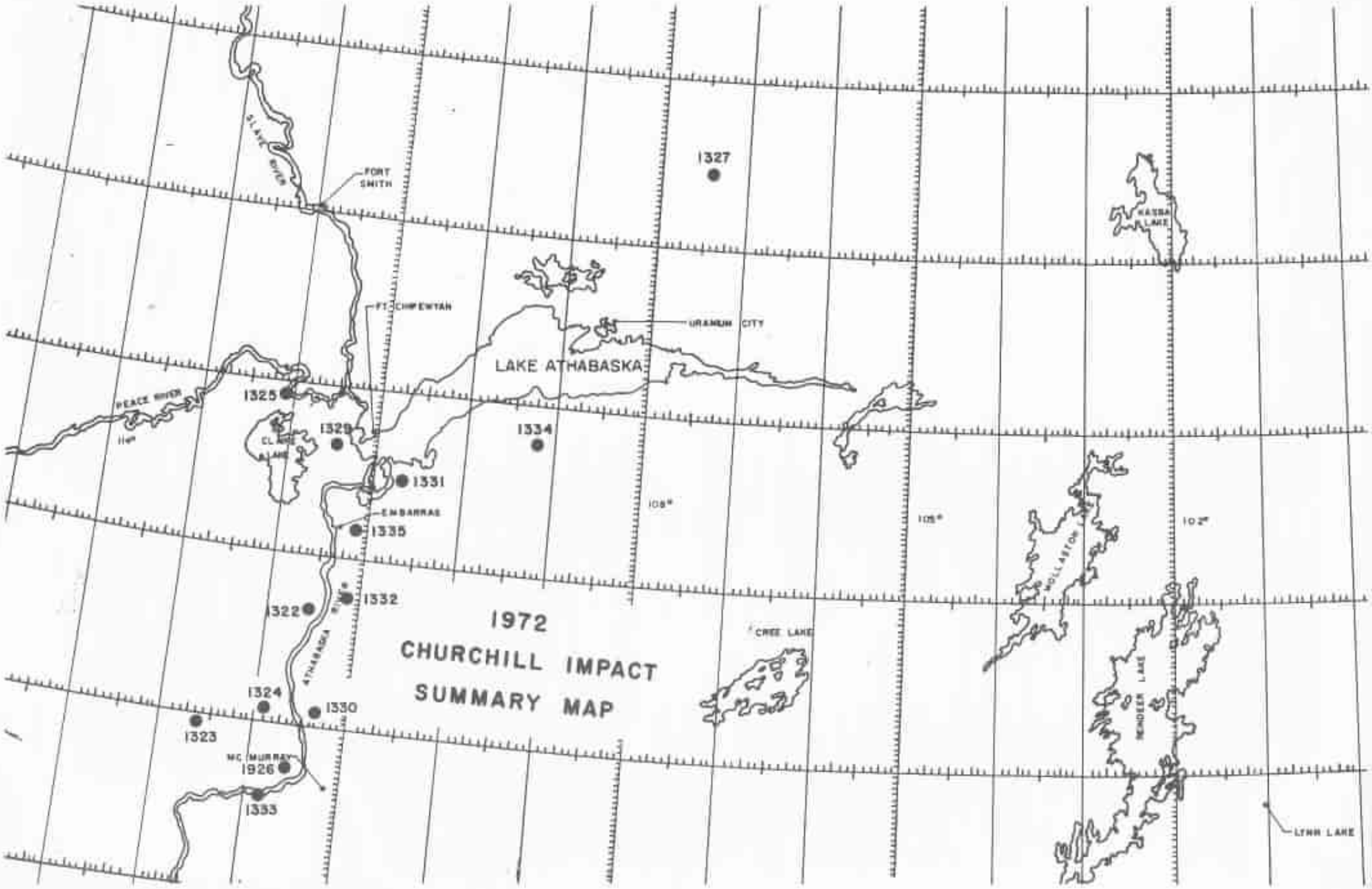


TABLE 3

Hitchhike Experiments

No. of Experiments	Flight No.	Scientist	Experiment	Weight
6	1322 1329 1331	Dr. Katsura Fukui, AFCRL Hanscom Field, Massachusetts	Plastic Stacks	8,8,8, 8,10 10 lbs.
3	1323 1328 1333	Centre Nat'l. D'etuds Spatiales	Biostack Shrimp Eggs	4 lbs.
4	1324 1327 1330 1336	Dr. H.R. Anderson Rice Univ. Houston, Tex.	Ionization Chamber	25 lbs.
1	1332	Dr. Hiroshi Hasegawa, Rikkyo Univ., Tokyo, Japan	Nuclear Emulsions and Plastic Sheets	20 lbs.
1	1336	Peter Raft AEC	Ionization Chamber	25 lbs.

Out of a total of thirty-five days in the field at Fort Churchill, twelve days, or 46% of the time was considered as "available" for flight purposes. Table 4 presents the breakdown of the days spent for or because of various reasons.

TABLE 4

Utilization of Field Time

Task	Number of Days
Set-Up Time	3
No Gondola Available for Flight	4
Weather	14
Flight Launched	12
De-activation	2

Contractor supplied personnel for the Skyhook Program consisted of eighteen men including the subcontracted helicopter pilot and mechanic. Assignments by function were:

Fort Churchill

1 Program Manager
1 Launch Director
1 Asst. Launch Director
2 Launch Technicians
1 Electronic Engineer
3 Electronic Technicians
1 C-47 Pilot
1 C-47 Co-pilot

Uranium City

2 Instrument Technicians
2 Cessna 206 Pilots
1 Helicopter Pilot
1 Helicopter Mechanic

Table 5 gives the organizational structure followed during 1972.

TABLE 5

Skyhook Administrative and Operational Organization

U.S. Navy
Office of Naval Research
Physics Branch, Code 421
Arlington, Virginia 20360

Physical Scientist: W.F. Martin
Project Officer : Cmdr. W.R. Wilson

U.S. Navy
ONR Field Office
Minneapolis, Minnesota 55111

Officer in Charge : Cmdr. W.F. Cross
Field Representative: M.O. Evanick

			Arrival Date	Departure Date
Program Manager:	T. Pappas		28 June	1 August
Instrumentation:	G. Kerschmann		26 June	31 July
	R. Boese		26 June	31 July
	G. Lindner	U.C.	28 June	2 August
	E. Erpelding		26 June	1 August
	M. Eastwold	U.C.	28 June	1 August
	C. Klos		26 June	31 July
Launch :	M.F. Fulkerson		22 June	1 August
	F.F. Vandersnick		26 June	1 August
	D. Reid		22 June	1 August
	D. Getting		26 June	31 July
	D. Rasmussen		26 June	1 August
Recovery :	A.C. Tomnitz		26 June	1 August
	J. Zangger		26 June	1 August
	R. Kerns	U.C.	23 June	1 August
	R. Broeske	U.C.	23 June	1 August
	G. Markham	U.C.	25 June	2 August
	W. Wilds	U.C.	25 June	2 August

Scientific personnel present for the three projects are listed in Table 6, 7, and 8.

TABLE 6

SKYHOOK PROGRAM PERSONNEL

Churchill Program

	Arrival Date	Departure Date
Office of Naval Research		
Mr. F.B. Isakson, Director Washington, D.C.	9 July	13 July
Commander Don Melton, Project Engr.	9 July	13 July
Mike O. Evanick, Field Rep. Minneapolis, Minnesota	27 June	31 August
Bob Muttel - USNR Photographer	7 June	19 July
Carl Johnson - USNR	14 July	27 July
National Aviation & Space Admin.		
Mr. E. Ott	9 July	13 July

TABLE 6 CONTINUED

	Arrival Date	Departure Date
Goddard Space Flight Center		
Dr. Robert C. Hartman	22 June	30 July
J.K. Daugherty	22 June	23 July
P.J. Schmidt	22 June	22 July
M. David Andrews	22 June	23 July
University of California-Riverside		
Dr. R.S. White	29 June	18 July
George Simnett	29 June	23 July
W. Millard	29 June	26 July
R. Walker	27 June	25 July
R. Koga	27 June	25 July
University of Calgary, Alberta, Canada		
Dr. C.J. Bland	25 July	30 July
Paul Siska	25 July	31 July
University of Chicago		
G. Fulks	24 June	30 July
Harold Boersma	22 June	31 July
University of Louisiana		
Dr. Satya "Sam" Verma	3 July	26 July
Dennis Herzo	4 July	26 July
Don Riddle	4 July	26 July
University of Maryland		
Dr. James Earl	4 July	2 August
Dr. J.J. O'Gallagher	4 July	30 July
Larry Bagg	28 June	4 August
Janet Luhman	4 July	30 July
H.W. Leach	1 July	30 July
Larry Vada	4 July	30 July

	Arrival Date	Departure Date
University of New Hampshire		
Dr. W.R. Webber	29 June	13 July
M. Tubman	29 June	17 July
Jerry Lezniak	29 June	17 July
Bill Evans	6 July	17 July
James Kish	29 June	17 July
Naval Research Laboratory		
H. O'Dell	29 June	4 July
G. Woods	29 June	4 July
Rice University - Houston		
Dr. Hugh R. Anderson	2 July	27 July

TABLE 7

Cape Girardeau Program

University of Chicago	Atomic Energy Commission
Inar Juliusson	Peter Raft
Harold Boersma	
John Caldwell	
Gary Kelderhouse	
University of California Riverside	**NASA - Goddard**
Dr. R.S. White	Bob Silverburg
George Simnett	Tony Puig
W. Millard	Russell Greer
Shin Moon	Frank Hagen
R. Walker	Mike Sokoloff
University of New Hampshire	**Washington University**
Jim Kish	Dr. Joe Klarmann
Dr. Jerry Lesniak	Dr. Martin Israel
Mike Tubman	Ron Mahl
	John Epstein
	Arville Taylor
	Patrick Love
	Julio Bengas

TABLE 8

Red Deer Program

Goddard Space Flight Center
Super Conducting Magnet Experiment

Dr. D.V. Reames
D. Enabnit

Mr. Rolan Hintz - Super Magnetics

$E^{\mp}$ Experiment

Dr. Robert C. Hartman
J.K. Daugherty
P.J. Schmidt
M. David Andrews

Raven Industries, Inc.

M. Fulkerson
G. Kerschmann
E. Erpelding
D. Reid
D. Rasmussen
L. Webber
A. Tomnitz
J. Zangger
T. Pappas
G. Lindner - Dauphin, Manitoba

Aircraft used for the Skyhook Program consisted of the Office of Naval Research C-47, Cessna 206 equipped with floats, and a Bell Jet Ranger leased for two months. Total flying time for all three aircraft was 349.15 hours. Time spent in actual tracking and recovery amounted to 224.8 hours, with the remainder in logistics or transportation to and from the site. Table 9 provides the detailed aircraft usages including all flights flown for the Office of Naval Research in 1972.

TABLE 9

Aircraft Flight Time Usage

Churchill Phase

Aircraft	Task	Operation Time (Hours)
Bell Helicopter		72.7 Hours
Cessna 206	Ferrytime	24.10
	Recovery & Tracking	59.10
C-47	Ferrytime	19.5
	Tracking & Recovery	94.0
	Maintenance	2.0
	Logistic Support	3.0
	TOTAL AIRCRAFT TIME	274.4
Average Time per A/C Per Flight		
Bell Helicopter		5.6
Cessna 206		4.5
C-47		7.2
	AVERAGE PER FLIGHT	17.3
	Cape Girardeau, Missouri	
Cessna 206	Ferrytime	9.5
	Tracking	20.2
C-47	Ferrytime	8.25
	Tracking	38.0
	TOTAL TIME	75.95
	Red Deer, Alberta, Canada	
C-47	Ferrytime	15
	Tracking	5.5
	TOTAL TIME	20.5

TABLE 9 CONTINUED

Aircraft - 206 Cessna Task	Operation Time (Hours)
Sioux Falls, South Dakota	
Flight 1319	6.30
Flight 1320	1.30
TOTAL TIME	8.00

Table 10, Radio Frequency Usage - 1972, lists all frequencies assigned to Raven Industries, Inc. for the Skyhook Program by the Office of Naval Research and DOT, along with a summary of accumulated transmission times.

TABLE 10

Radio Frequency Usage - 1972

May - 1972

Frequency	Emission	Power (Watts)	Total Transmit Hours
149.4 MHz	30F9	80	36
253.1 MHz	350F9	5	6
256.2 MHz	350F9	5	30

July - 1972

7.465 MHz	3A3J	100	258
149.4 MHz	30F9	80	258
248.6 MHz	350F9	5	77
250.7 MHz	350F9	5	75
253.8 MHz	350F9	5	42
256.2 MHz	350F9	5	64
152.5 MHz	350F9	5	34

TABLE 10 CONTINUED

September - 1972

Frequency	Emission	Power (Watts)	Total Transmit Hours
149.4 MHz	30F9	80	157
250.7 MHz	350F9	5	62
253.8 MHz	350F9	5	31
256.2 MHz	350F9	5	95

October - 1972

149.4 MHz	30F9	80	10
248.6 MHz	350F9	5	2
250.7 MHz	350F9	5	27
253.1 MHz	350F9	5	27
256.2 MHz	350F9	5	12

Instrumentation for the 1972 Program was the same as used since 1969. Raven provided six separate control instruments.

Basically, the radio command subassembly consists of a miniature Motorola, solid-state receiver, and Raven-designed decoders and output circuitry. The decoder is equipped with six channels with a capability of being expanded to twelve simply by inserting another circuit board. Standard channel assignments are termination, ballast, and four spares. The termination output circuit, along with the command receiver, operate from a separate NiCad battery providing completely independent power in the event of main power supply deterioration. The ballast channel provides a pre-timed thirty-second drop for every command initiation. Other output channels are routed to a matrix card where they may be used as desired.

The telemetry subassembly includes the transmitter, subcarrier oscillators, commutator, and two input/output matrix cards. The transmitter operates between 225 to 260 MHz. with a nominal three watts of FM power. Up to five subcarrier oscillators may be accommodated. The commutator switches altitude information into the transmitter, as well

as provides two, ten-segment channels for other data. A second commutator board may be added to allow commutation of all five subcarrier oscillators.

Appropriate circuitry provides "ranging" from the ground stations to the balloon and also allows transponding of voice communication between the two stations or between the ground stations and the aircraft.

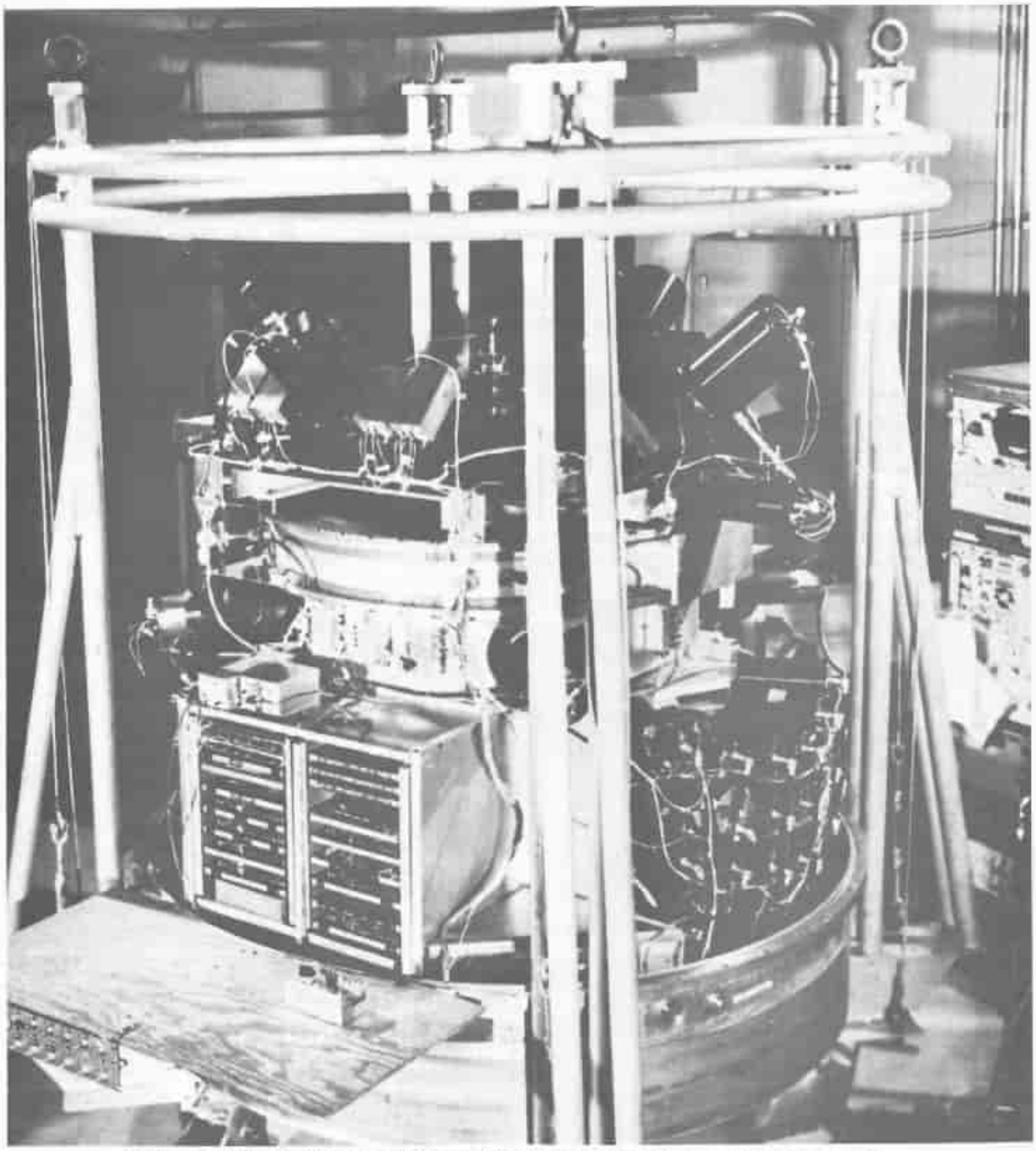
With the exception of the receiver and command output, all voltages are derived from a 24 volt, 20 ampere-hour Silver-Zinc storage battery. A power converter, auxiliary battery, and regulator provide lower voltages for various subassemblies within the flight package.

During 1972, several control instrument problems arose which caused premature termination. Flight 1320 was terminated by timer as ballast was being dropped. Flight 1321 was terminated during ballast drop. Flight 1324 terminated the balloon due to shock forces imparted to the instrument container during a launch abort. Flight 1338, an improper timer setting terminated thirty hours early. Flight 1339, control instrument intermittent operation due to low temperature. Flight 1341, ballast command inoperative approximately three hours.

The last year of operation for the Raven TRAC^{R} package was 1972 due to Federal Regulations requiring frequency changes. During its four-year history, the instrument had been used on 91 Skyhook flights.

III. FLIGHT DESCRIPTIONS

A. Fort Churchill Program



NASA-Goddard Space Flight Center's package during calibration and checkout prior to flight for Dr. Ormes.

1319 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
4 April 1972
Dr. T. Cline

A small experiment, by physical proportions, it weighed 282 pounds, measured 20 inches in diameter, and was approximately 60 inches tall.

The purpose of the experiment was an intercalibration flight to compare four different satellite spare detectors in order to determine relative responses of IMP-A, OGO-B, OGO-E, and IMP-H electron experiments using cosmic ray secondary electrons at balloon altitudes (95 to 125,000 feet).

The gondola formed a compact package which included the Raven control instruments, ballast hoppers, and dual back-up termination timers. Suspended from a 2.94 MCF balloon with a 38 foot diameter parachute, the system was sent aloft without incident.

After twenty-seven hours at ceiling, the flight was terminated and recovered three miles southwest of Fergus Falls, Minnesota.

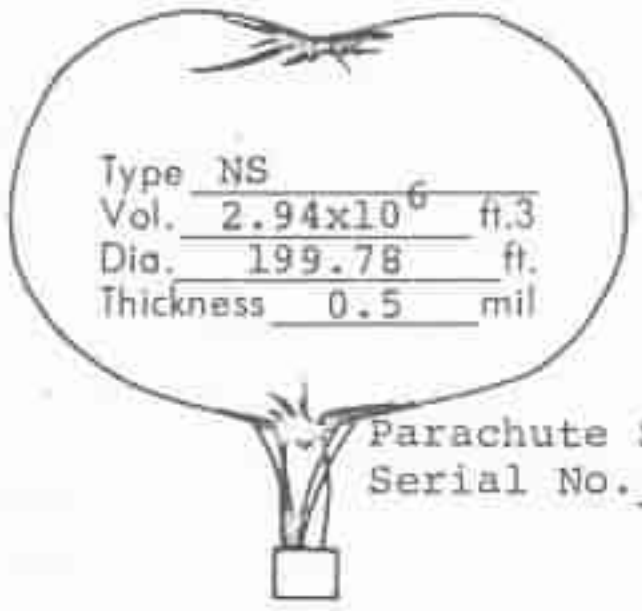
The flight was considered a scientific success.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1319 Director Fulkerson
2. Scientist Cline Group GSFC Date/Time 5-4-72/ 1350 Z
3. Launch: Site Sioux Falls, S.D. Technique/Launch Veh. Dynamic M-36
4. Wx: Clear 35°F 340° 8 MPH Cross Wind Angle 0°
   (Sky-Temp-Wind-Pressure)
   Trop (Coldest) Ht. 38,000 ft. Temp -58.7 °C Inflation Start 1310 Z
   Hrs. Sunshine on Bubble --- Train Length (Layout) 300 ft.
5. Balloon: Theoretical 4.15 - 3.65 Mbs. 123.0 - 126.2 K ft. How Determined? MFG Curve
   Ceiling: Actual 3.5 Mbs. 127.3 K ft Transducer
6. Ascent: Surfact to Trop. 864 fpm Trop. to Ceiling 694 fpm
7. Flight Duration: Total 29 hrs. 55 min. At Ceiling 26 hrs. 22 min.
8. Termination: Time 1857 Z Altitude 123.0 K ft. Cause R/C
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 5-5-72/ 1945 Z Location 96° 10' W 46° 14' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	30.0
149.4	Communications & Command	30.0

12. Balloon: Code Number SP 199.78-050-NS-5 Serial Number 324



WEIGHTS

Balloon	357
Parachute	42
Instrumentation Raven	51
Ballast	150
Scientific Package	282
Other Crush Pad	10
Other Timers	8
Gross Weight	900
Free Lift 12%	108
Gross Inflation	1,008
Helium used (cu. ft.)	15,624

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments
    (Significant factors concerning the operation)

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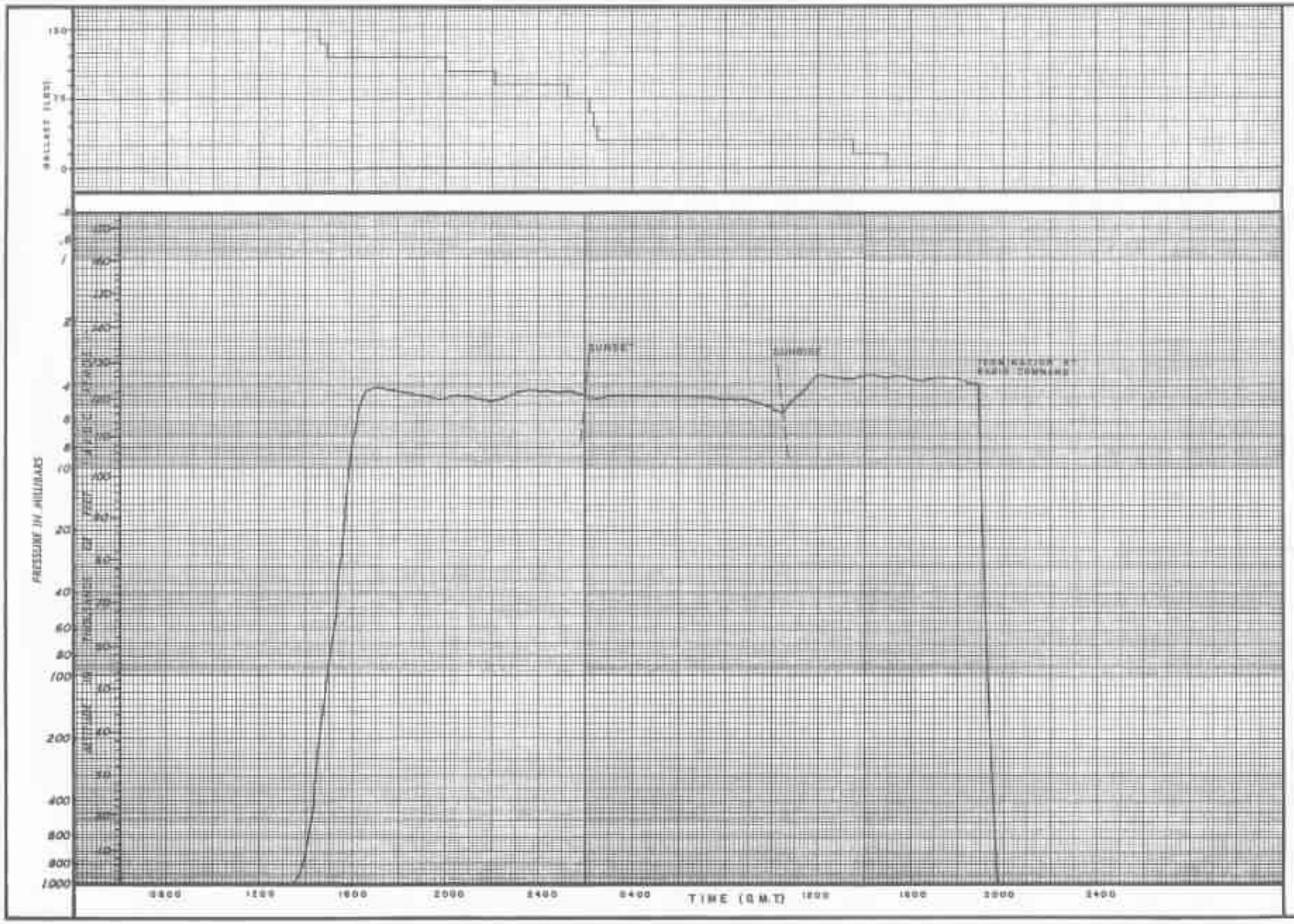
ONR/Code 421



FLIGHT NO. 1319

DATE: 5-4-72

FOR: GSFC

BALLOON

TYPE: NS

VOL: 2.94 x 10^6 FT.^{3}

MATL: 0.5 MIL

WT: 357

LOAD FACTORS

PAYLOAD:	543
CROSS LD:	900
FREE LIFT:	108
BALLAST:	150

RAVEN industries, inc.

DR.

CHK.

APPR.

1320 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
16 May 1972
Dr. Ormes

The original proposal requested a flight on a 33.1 MCF balloon from a southwestern United State launch site in early spring of 1971, as part of the Office of Naval Research Skyhook Program. After numerous delays and changes, the experiment finally arrived in Sioux Falls, South Dakota, in early May of 1972.

The primary purpose of the experiment was the study of cosmic ray electrons, positrons, and heavy nuclei in the high energy region. The experiment was equipped with two main sections: a charge determination module and an electro-magnetic cascade section.

The charge determination section has two plastic scintillators, a quartz Cerenkov counter, and a Pilot 425 Cerenkov counter. The electro-magnetic cascade module contains alternate layers of tungsten and plastic scintillator. These allow frequent sampling of showers caused by electrons and positrons. The detector also contains a time of flight measurement and a digital spark chamber which allow for background rejection and provide particle trajectory information.

The experiment's electronic equipment provided pulse height information on the twenty-four detectors and on the spark chamber. One of the detectors is connected to a logarithmic pulse amplifier whose output is proportional to the logarithmic of the input pulse. Much of the package is similar in design to an experiment which will be flown on the first High Energy Astrophysical Observatory (HEAO) satellite to be launched in 1975.

A large and heavy experiment, the gondola, was a cylindrical shape six feet in diameter and about 8-1/2 feet tall, weighing 2,530 pounds. The balloon selected was a Winzen 33.1 million cubic foot, of 0.9 mil with two 0.9 mil caps. The balloon weighed 3,647 pounds. Support equipment, such as ballast, hoppers, timers, balloon control instrumentation, and parachute, brought the gross system weight up to 7,213 pounds, which was the heaviest flight to be launched by Raven up to that time. To launch the flight, a crane was equipped with a pin fitting. To prevent possible snagging or tangling of the parachute riser on

the crane boom, the boom was covered with a heavy canvas. A set of four, 1/4-inch cables 50 feet long were installed between the parachute and gondola.

An 84.2 foot diameter Ringsail parachute was selected because of its light weight and its high geometric porosity provides less shock during initial inflation and descent.

The maximum descent weight, including ballast, was 3,566 pounds which could have resulted in an impact velocity of 32 feet per second. This was minimized by providing ballast dump doors on the ballast hoppers, which reduced the weight to 2,816 for a 24 foot per second descent velocity, in the event descent began before ballast was all expended.

Hardware on top of the chute included the two double squib cannons, the aluminum connector attaching the chute to the release line, and the seven pound independent back-up timer and battery.

Control instrumentation and a second timer were mounted on the gondola. The timer was located opposite the control package as a precaution against both being damaged in the event of a poor launch.

Raven instrumentation provided three command channels for switching the experiment on and off and from one mode to another, and a transmitter and power supply for the NASA data telemetry.

The balloon manufacturer had a representative oh site to assist with the field modification of the balloon. It seems the balloon was built with one gore folded around the balloon. To this same gore was attached the reefing sleeve. The field modification consisted of ripping open the sleeve and folding the gore back so all load tapes were on one side.

On May 16, ideal weather conditions prevailed so the flight was scheduled. Layout and inflation required approximately two and one-half hours.

The balloon was laid out north and south, with a three MPH wind in perfect alignment up to 600 feet; above 600 feet the wind direction was southwesterly.

The actual launch was smooth, however, the retainer line released a split second after the balloon was over the pin, which let the gondola swing down and to the side.

An ascent rate of 808 FPM was established after launch and remained constant until reaching the tropopause at 38,000 feet, where 36 pounds of ballast was expended.

As the balloon was ascending through 122,000 feet, additional ballast was dropped. Seconds later telemetry indicated the gondola was in descent.

Controllers confirmed the descent and immediately transmitted the termination command to sever the balloon in case it was a burst.

The flight landed thirty miles south of Sioux Falls twenty-eight minutes later.

A post-flight analysis of the failure indicated the following:

> The initial conclusion of the ground controllers and other observers was that the mis-firing was associated with ballast command in close time coincidence with the termination. The negative aspect of this reasoning was that this same secondary command channel had been used twice previously with no malfunction. Nothing in the command package circuit design can account for this "third time" operation; and post-flight inspection of the balloon train electronics cleared the command system from fault and that the "cut down" was just coincidental with the other command being given at the time.
>
> Post-flight inspection of the parachute load line and squibs showed that the parachute-mounted back-up timer had cut the lines. Even though the "chute timer" had torn loose on descent and free fell, it was packed in a thick styrofoam box and survived the impact with little damage. The timer had run down in 4 hours and 57 minutes from its initial setting of 30 hours.
>
> The timer is a commercially purchased unit manufactured by the A.W. Haydon Co. as their Model W6498 0-40 hour time delay relay. This device has been used by Raven Industries, Inc. as a back-up termination device for the past five years and has had an excellent record of reliability. The failure could very well have been prevented by closer

pre-flight inspection.

The timer consists basically of: a chronometric governed drive motor which, through a reduction gear train and slip clutch, drives an actuating arm toward a microswitch that in turn fires the squib. The slip clutch is in turn actuated by a solenoid, which allows the microswitch actuator arm to fall back or "reset" to the initial time setting (in the case of this flight, +30 hours). However, during post-flight checking of the device, it was found that the clutch did not release completely and the arm did not rotate more than 4 or 5 hours back from its fired position. No visual confirmation is available to the flight line technician other than an audible "click" of the reset solenoid. The timers have since been modified by drilling an inspection hole in the timer housing for a more reliable means of checking for full reset of the device.

The experiment was having some minor difficulties which scientists were unable to diagnose during flight. After removing the cover from the gondola to recheck the experiment, it was found to have suffered extensive structural damage from impact. A reflight for the experiment was not immediately possible, and it was returned to Goddard Space Flight Center for refurbishing.

First indications were that the descent was excessively fast, at about 28.9 FPS; this turned out to be the descent velocity with a ringslot. The Ringsail parachute used was similar to a solid canopy which calculates to be 24 FPS.

Since the flight was experiencing some operational difficulty, it was theorized that some of the structural damage may have occurred during launch. The launch, while not perfect, was smooth, and no undue forces were imparted to the gondola.

The next flight attempt to be made in August or September of 1972.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1320 Director Fulkerson
2. Scientist Ormes Group GSFC Date/Time 6-16-72/ 1305 Z
3. Launch: Site Sioux Falls, S.D. Technique/Launch Veh. Dynamic - Crane
4. Wx: Clear 62°F 3 MPH SLP-1010.6 Cross Wind Angle 0°
   (Sky-Temp-Wind-Pressure)

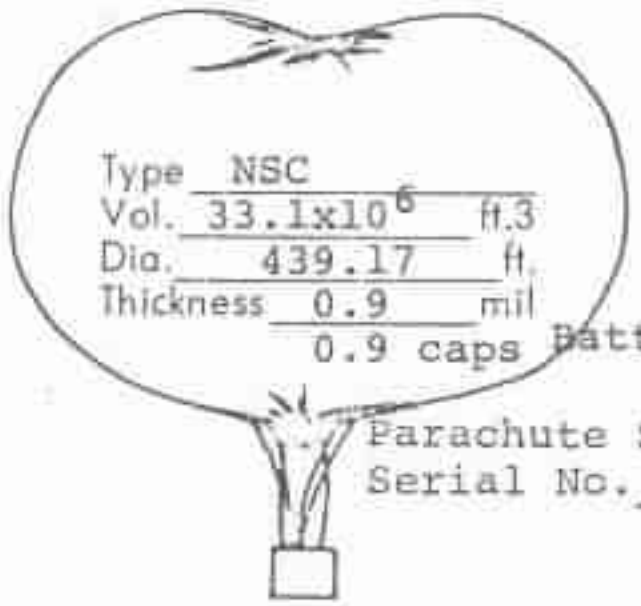
   Trop (Coldest) Ht. 38,000 ft. Temp -56.0 °C Inflation Start 1200 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 825 ft.
5. Balloon: Theoretical 3.05 - 2.75 Mbs. 130.7 - 133.5 K ft. How Determined? MFG Curve

   Ceiling: Actual --- Mbs. --- ft ---
6. Ascent: Surfact to Trop. 808 fpm Trop. to Ceiling --- fpm
7. Flight Duration: Total 4 hrs. 23 min. At Ceiling -- hrs. -- min.
8. Termination: Time 1657 Z Altitude 122.0 K ft. Cause Timer
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 6-16-72/ 1728 Z Location 96° 45' W 43° 03' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
253.1	Telemetry	6.0
149.4	Communications & Command	6.0

12. Balloon: Code Number SF 439.17-090-NSC-01 Serial Number 1



WEIGHTS

Balloon	3,647
Parachute	127
Instrumentation Raven	60
Ballast	750
Scientific Package	2,502
Other Pin Fitting	50
Other Crush Pad	67
Gross Weight	7,213
Free Lift 10%	721
Gross Inflation	7,934
Helium used (cu. ft.)	122,927

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Flight terminated three hours and fifty-two minutes after launch. Timer cutdown.
    (Significant factors concerning the operation)

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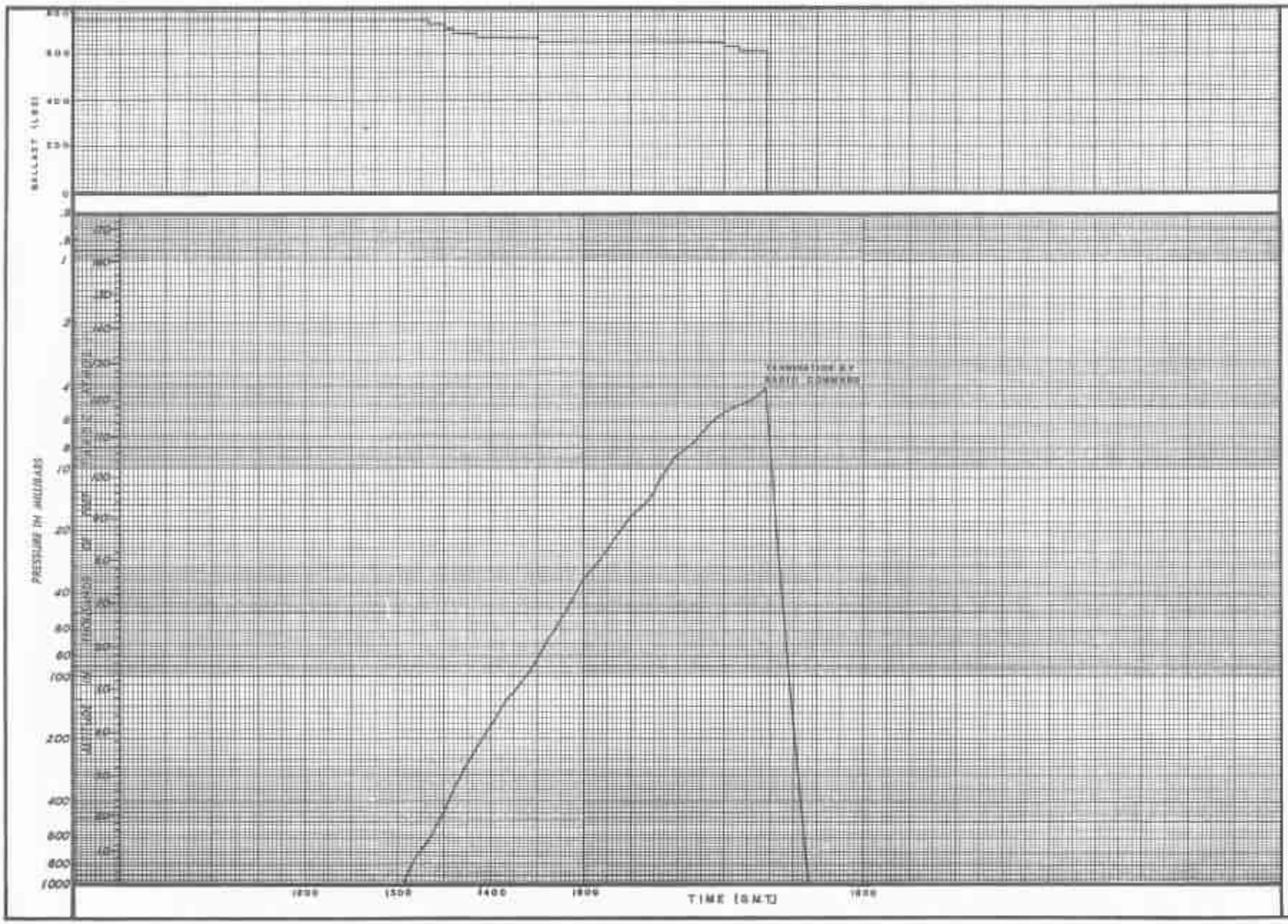
ONR/Fld Rep/Minn
ONR/Code 421



FLIGHT NO. 1320

DATE: 5-16-72

FOR: GSFC

BALLOON

TYPE: NSC

VOL: 33.1×10^6 FT.^{3}

MAT: 0.9 MIL/0.9 CAP

WT: 3647

LOAD FACTORS

PAYLOAD: 3566

GROSS LD: 7213

FREE LIFT: 721

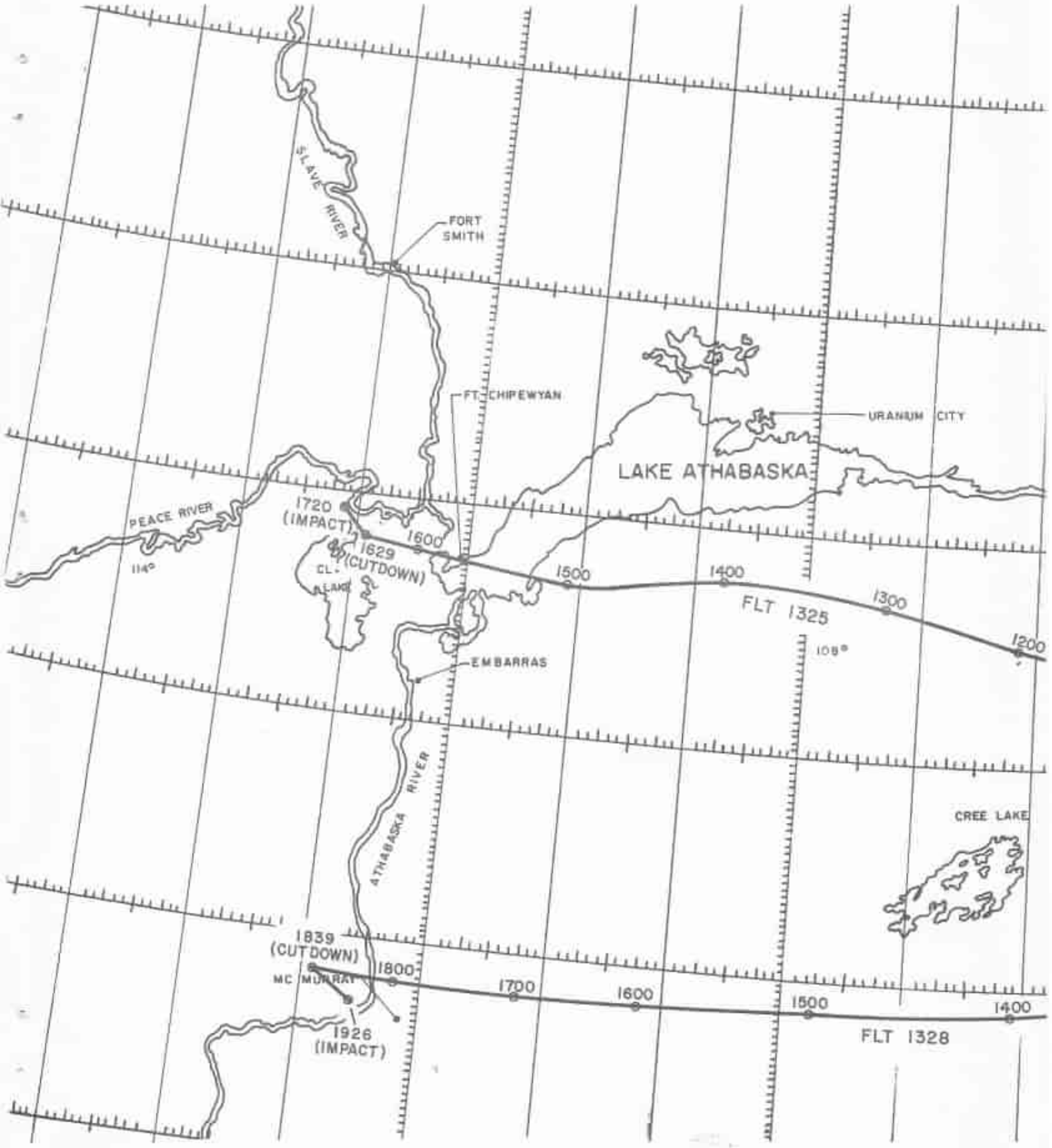
BALLAST: 750

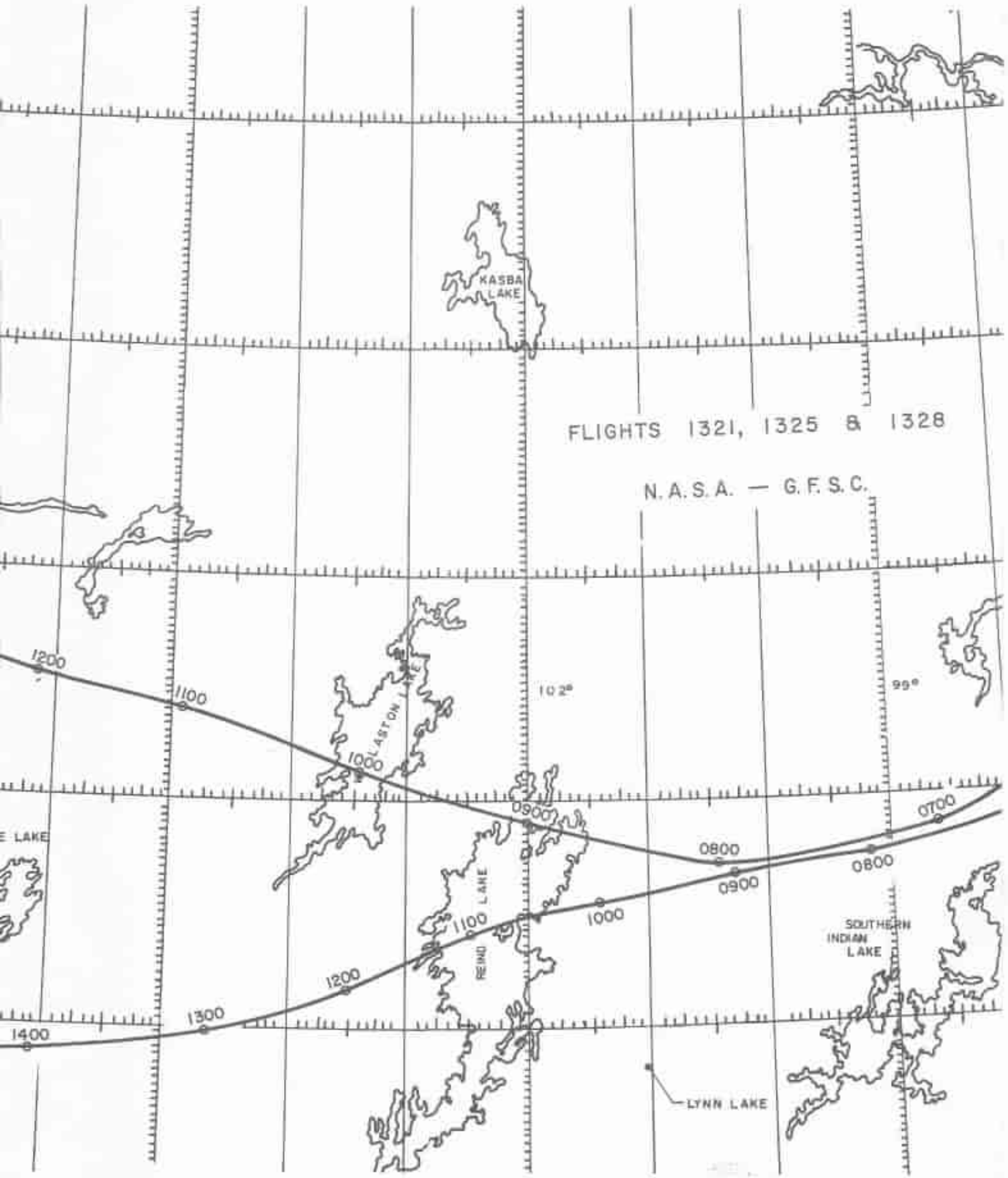
RAVEN industries, inc.

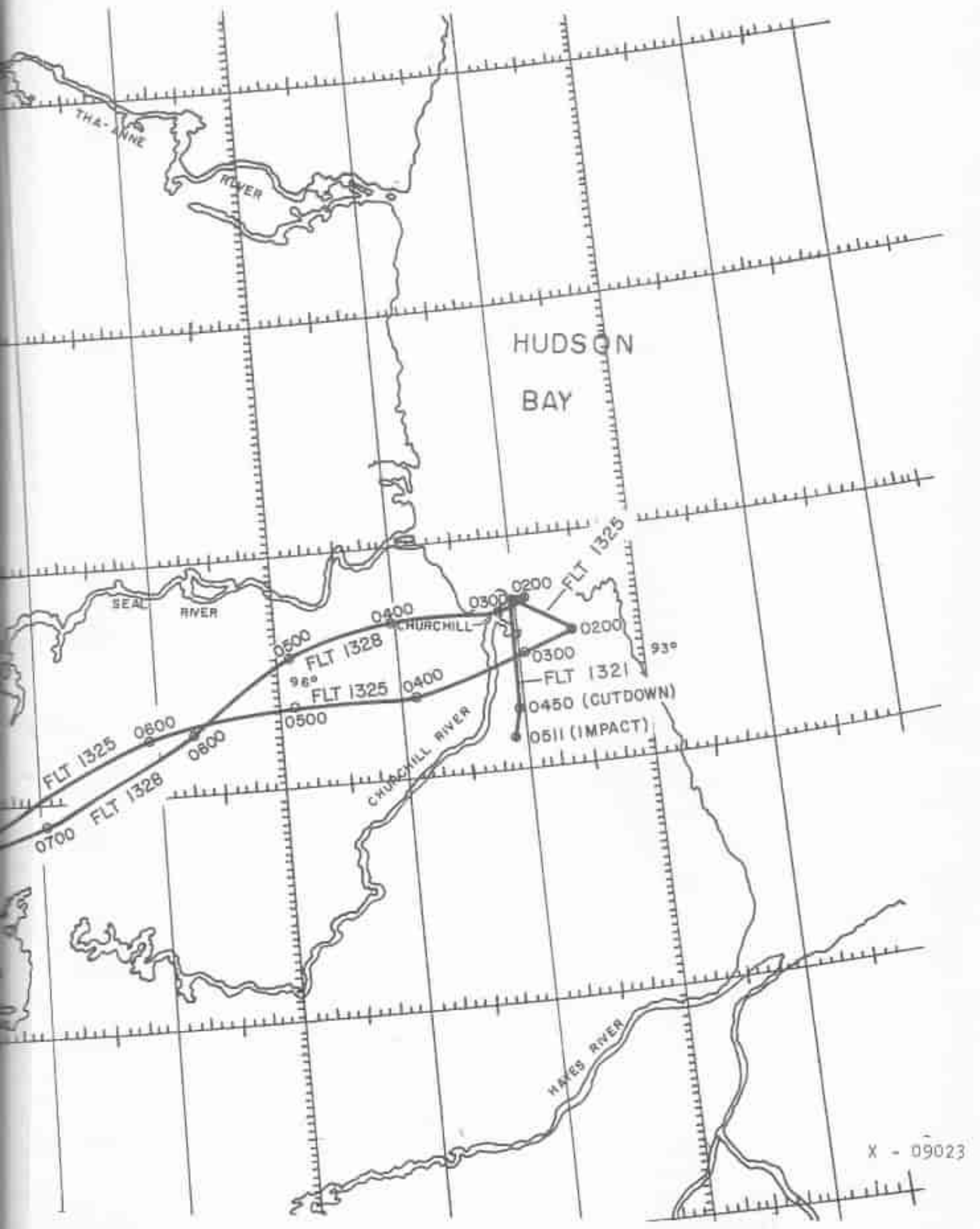
DR._____

CHK._____

APPR._____


SLAVE RIVER
FORT SMITH
FT. CHIPEWYAN
URANIUM CITY
LAKE ATHABASKA
PEACE RIVER
1720
(IMPACT)
1629
(CUTDOWN)
1600
1500
1400
1300
1200
FLT 1325
114°
CL.
ALAKE
EMBARRAS
108°
ATHABASKA RIVER
CREE LAKE
1839
(CUTDOWN)
1800
1700
1600
1500
1400
MC MURRAY
1926
(IMPACT)
FLT 1328


KASBA LAKE
FLIGHTS 1321, 1325 & 1328
N.A.S.A. — G.F.S.C.
1200
1100
1000
0900
0800
0700
102°
99°
LAKE
LAKE
1000
1100
1200
1300
1400
SOUTHERN INDIAN LAKE
LYNN LAKE


HUDSON
BAY
SEAL RIVER
CHURCHILL
CHURCHILL RIVER
HAYES RIVER
0200
0300
0400
0500
0600
0700
FLT 1325
FLT 1328
FLT 1321
96°
93°
0450 (CUTDOWN)
0511 (IMPACT)
X - 09023

1321 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
3 July 1972
Dr. R. Hartman, J.K. Daugherty

One of the largest experiments to be flown from Fort Churchill was scheduled for two flights. The first flight to be performed with an 18.5 million cubic foot balloon, while the second utilized a 30.5 MCF balloon. An 18.5 MCF balloon left over from a previous expedition was to be a spare.

The experiment was designed to measure primary electron/positron ratio in the energy range from about 20 MeV to 400 MeV. The detector employed two core-readout spark chambers separated by a one kilogram permanent magnet with pole faces 95 x 15 cm^2 and a gap distance of 8 cm. The field integral was about 20 kilogram-cm. A scintillator telescope system with a geometry factor of about

Commander Melton, Mr. Isakson, and Mike Evanick discuss recovery with Raven's pilot, Allen Tomnitz.

18 cm^2 was used to trigger the spark chamber on partical events. A gas Cerenkov threshold counter containing CO_2 at one atmosphere provided a directional telescope requirement and excluded proton events below 30 GeV.

An additional means of distinguishing electrons from heavier particles was provided by a lead scintillator sandwich array placed below the lower spark chamber. This calorimeter package employed two three-inch phototubes, each equipped with an on-board pulse height analyzer. The PHA outputs were fed into the data stream, along with spark chamber data and housekeeping information. All data was transmitted by a PCM telemetry system to ground stations at Fort Churchill and Uranium City. The Fort Churchill and Uranium City stations were manned by both Goddard Space Flight Center staff and Raven personnel.

Mr. Ott of NASA discusses instruments and problems with Raven's electronics engineer.

The standard Raven control instrument package provided altitude and pressure data, ranging, and commands for termination and ballasting.

The experiment, when ready for flight, weighed 1,373 pounds, 572 pounds of which was ballast and control instruments. The gondola was suspended on a 67 foot parachute which would provide a descent rate of 21 FPM (with full ballast).

Launch was performed smoothly after the launch truck maneuvered some 200 feet to position the gondola for lift off.

A normal ascent began at 750 to 800 FPM. Tropopause height was 36,000 feet, at which point the balloon began to cool and slow its ascent. The control center transmitted a ballast command. Seconds later telemetry indicated the system was descending on the parachute. The descending experiment was tracked to impact 45 miles south of Fort Churchill.

The following morning a fellow scientist and the Raven launch director used a Cessna 182 aircraft to locate the gondola. The ranging data was accurate and the gondola was easily located.

Recovery required a helicopter so local agents of Lamb Air Limited were contacted. The nearest suitable helicopter was located at Fort Thompson. Since the cost was substantial, it was decided to bring in the Uranium City helicopter crew to perform the recovery. However, at the same time a rescue mission being conducted fifty miles north of Fort Churchill required a helicopter. Arrangements were made to use this helicopter after the rescue mission was complete.

Shortly after midnight on the 4th of July, the gondola was returned to the Raven hangar.

Impact damage was confined to the expendable crush pad. The instrument was checked out and found to be in very good condition.

This flight was very similar to Flight 1313 in 1971 which terminated during ballast drop. In checking all available data from both flights, the following details evolved:

1. Both flights had the instrument mounted on plywood, with no common ground to the frame or to the scientific experiment.

2. Both flights terminated on ascent when ballast command transmitted.

3. Both flights had scientific data telemetry over separate antennas.

Since the failure could not be duplicated on the bench or at flight line, the instrument was completely dismantled during the checkout and was not flown again. All flights with plywood mounts were provided with grounding straps, and the distance between antennas was increased to the maximum.

The gondola was ready for reflight on 7 July. The second flight was to be on a 30.5 MCF balloon.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1321 Director Fulkerson
2. Scientist Hartman Group GSFC Date/Time 7-3-72/ 0400 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 120 @ 200 - @ 47°F 340° 8 MPH SLP-1024.5 Cross Wind Angle 40°
   (Sky-Temp-Wind-Pressure)

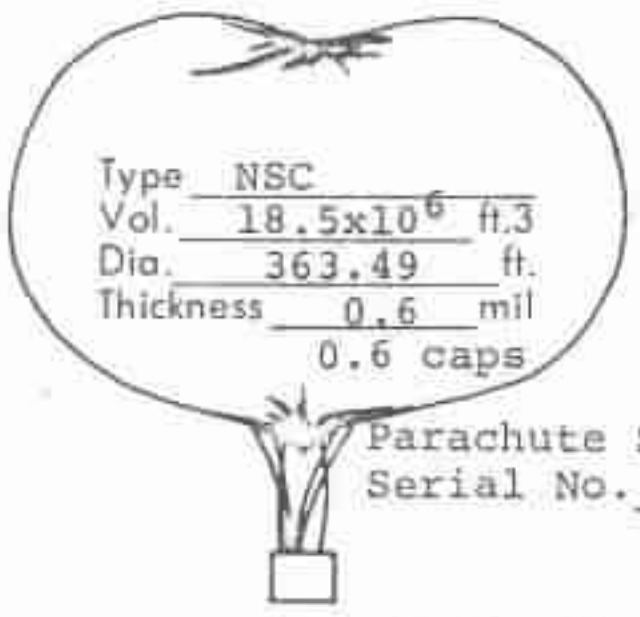
   Trop (Coldest) Ht. 36,000 ft. Temp -52.0 °C Inflation Start 0315 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 600 ft.
5. Balloon: Theoretical 2.82 - 2.37 Mbs. 136.1 - 140.6 K ft. How Determined? MFG Curve

   Ceiling: Actual --- Mbs. --- ft Transducer
6. Ascent: Surfact to Trop. 720 fpm Trop. to Ceiling --- fpm
7. Flight Duration: Total 1 hrs. 11 min. At Ceiling -- hrs. -- min.
8. Termination: Time 0450 Z Altitude 36.0 K ft. Cause Command
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-3-72/ 0511 Z Location 40 miles south of Ft. Churchill
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
248.6	Telemetry	2.0
149.4	Communications & Command	2.0
7465	Communications	2.0

12. Balloon: Code Number SF 363.49-060-NSC-03 Serial Number 10



WEIGHTS

Balloon	1,910
Parachute & Rigging	89
Instrumentation Raven	58
Ballast	500
Scientific Package	800
Other Crush Pad	15
Other	
Gross Weight	3,372
Free Lift 14%	472
Gross Inflation	3,844
Helium used (cu. ft.)	59,582

13. Flight Failures Terminated when ballast command transmitted.
    (Nature of flight failures - if any)
14. Comments
    (Significant factors concerning the operation)

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ONR/Code 421

1325 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
7 August 1972
Dr. R. Hartman

This was the same experiment as flown on Flight 1321, with the exception of the balloon, which was a 30.5 MCF and had an additional 300 pounds of ballast.

While not the largest balloon ever used on the Churchill Skyhook Program over the past few years, it was the largest by weight. Two larger light weight balloons (33.8 MCF, 1860 pound) attempted in 1971 were unsuccessful.

The balloon, constructed of Stratofilm, had a 0.6 mil shell and two 0.7 caps. When laid out on the ground,

Office of Naval Research Representative Mike Evanick and Mr. Isakson check weather data.

the balloon measured 593 feet long. Because of its length and the large size of the starting bubble, a 30.5 MCF balloon requires better than average launch conditions--conditions not normally seen at Churchill.

A gross system weight of 4139 pounds, plus 14% free lift for a total gross inflation of 4719 pounds, was the heaviest system ever flown from Fort Churchill.

A large launch arm was used for this flight because the thickness of material required a wider roller. The initial bubble length was 55 feet. Light winds prevailed during the inflation, which required 26 minutes.

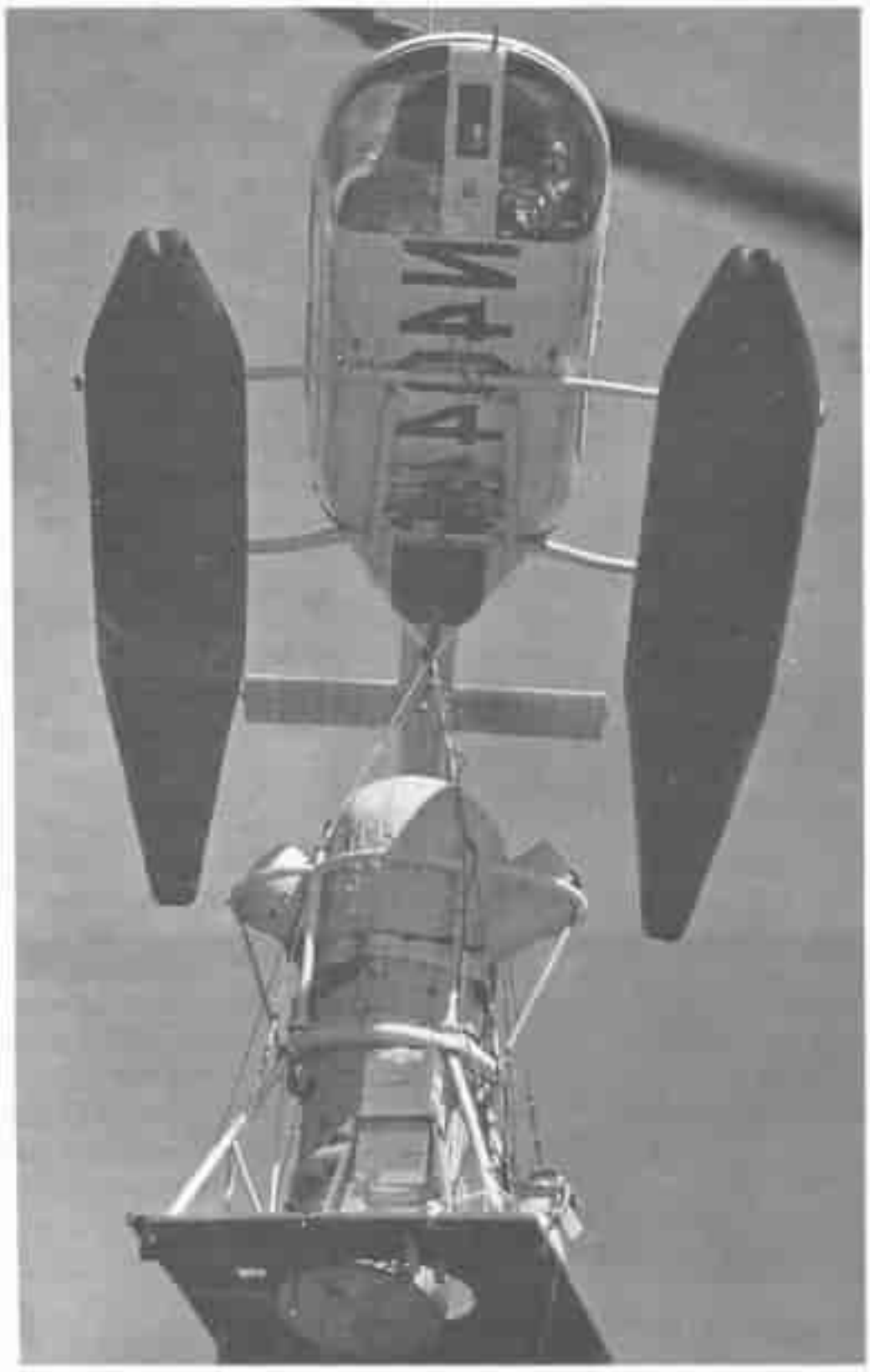
At the 450 to 500 foot level, winds were 15° off from the balloon layout. Launch was performed smoothly, with the gondola leaving the pin at a slight angle. A brisk ascent of 1000 FPM to the tropopause occurred where controllers dropped 60 pounds to maintain the ascent.

At 35,000 feet altitude, Goddard telemetry indicated low pressure in one of the three separate chambers of the gondola. The most likely cause of the loss of pressure was a leaking seal or loose Marmon clamp. It was feared that the thin aluminum barrier between the two chambers would rupture, destroying the spark chamber. The spark chamber was to be used in another experiment later in the fall. Termination of this flight was considered as an alternative to losing the spark chamber.

Aside from the low pressure, every aspect of the experiment was performing perfectly. The balloon reached a ceiling of 2.1 Mbs, 4 hours and 33 minutes after launch.

After 10 hours and 20 minutes at ceiling, the flight was terminated by command by Uranium City. Impact occurred 51 minutes later in Lake Clair, 40 miles west of Fort Chipawan. Returned to Churchill the following day, the gondola appeared to be in good condition.

Raven control instruments had taken on some water which damaged the battery pack.



The Bell Jet Ranger is lowering the package to be loaded on the C-47 for return to Fort Churchill.

The gondola was taken to Uranium City Airport and loaded into the C-47 for return to Fort Churchill.

The experiment was ready for reflight on 11 July, but was cancelled numerous times due to weather.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1325 Director Fulkerson
2. Scientist Hartman Group GSFC Date/Time 7-7-72/ 0056 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 2500 · 49°F Calm SLP-1019.8 Cross Wind Angle 0°
   (Sky-Temp-Wind-Pressure)

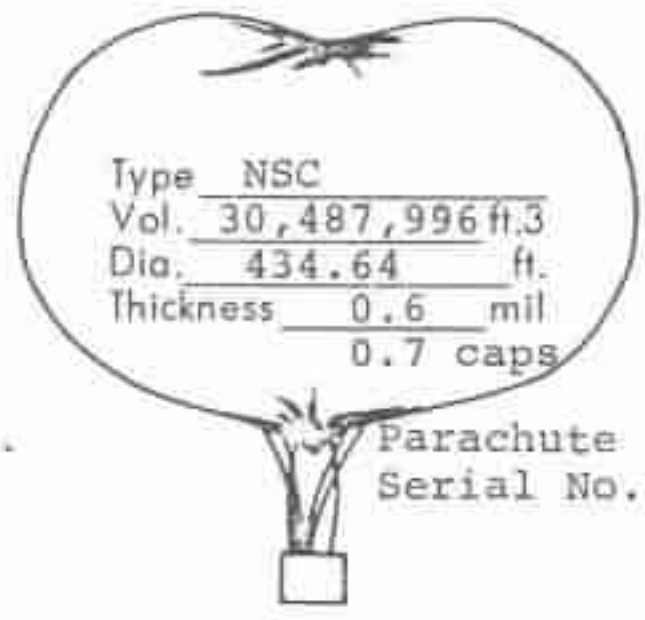
   Trop (Coldest) Ht. 32,500 ft. Temp -55.0 °C Inflation Start 0020 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 700 ft.
5. Balloon: Theoretical 2.3 - 1.96 Mbs. 141.4 - 145.6 K ft. How Determined? MFG Curve

   Ceiling: Actual 1.45 Mbs. 153.7 ft Transducer
6. Ascent: Surfact to Trop. 1,016 fpm Trop. to Ceiling 583 fpm
7. Flight Duration: Total 16 hrs. 24 min. At Ceiling 11 hrs. 59 min.
8. Termination: Time 1629 Z Altitude 150.0 K ft. Cause R/C - UC
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-7-72/ 1720 Z Location 112° 09' W 58° 56' N
    40 miles West of Chippwan
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	19.0
149.4	Communications & Command	19.0
7465	Communications	19.0

12. Balloon: Code Number SF 434.64-060--NSC-03 Serial Number 5



WEIGHTS

Balloon	2,576
Parachute & Rigging	89
Timer & Instrumentation Raven	58
Ballast	600
Scientific Package	800
Other Crush. Rad	16
Other	
Gross Weight	4,139
Free Lift 14%	580
Gross Inflation	4,719
Helium used (cu. ft.)	73,144

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments
    (Significant factors concerning the operation)

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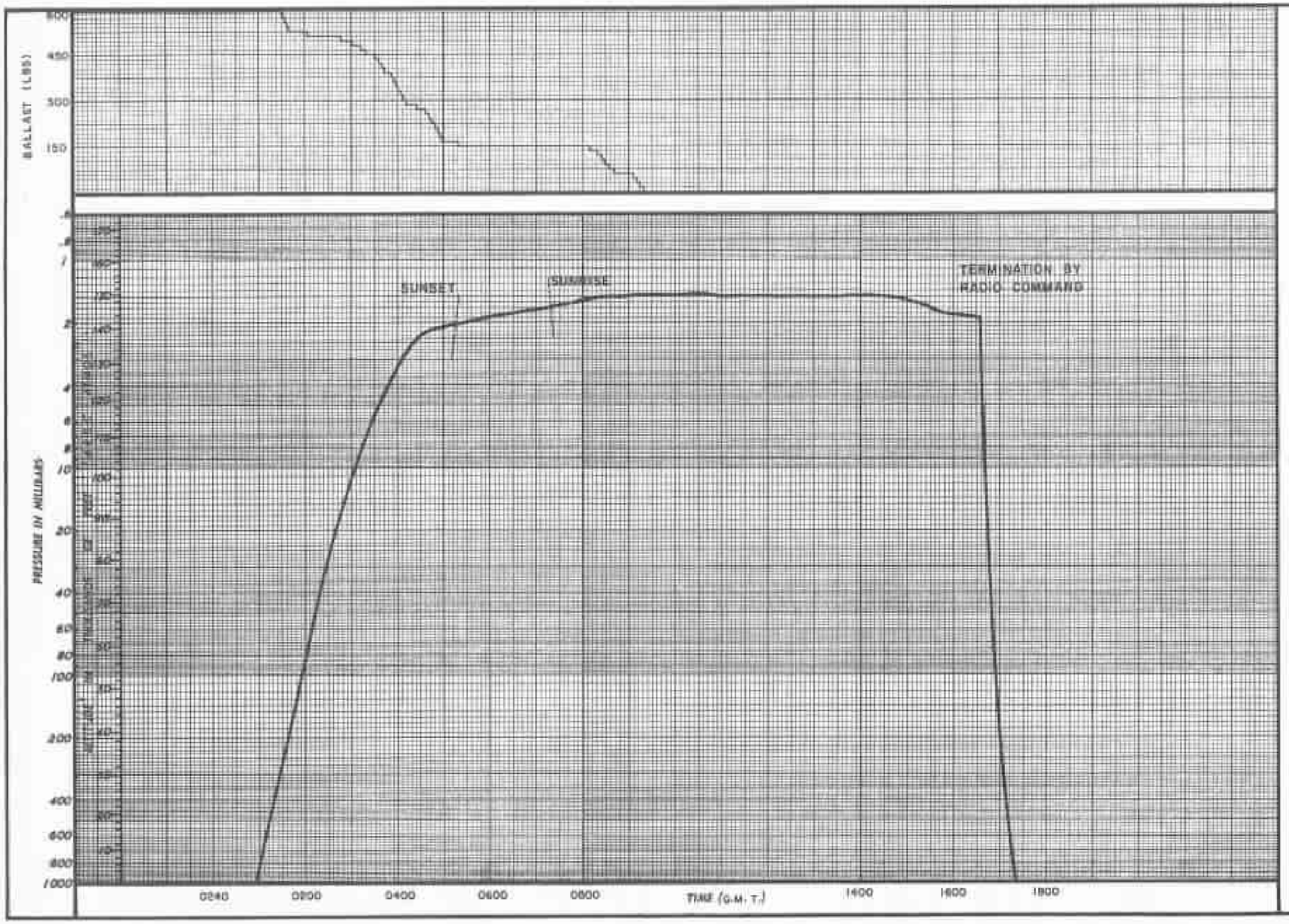
ONR/Code 421



FLIGHT NO. 1325

DATE: 7 JULY 72

FOR: N.A.S.A.-G.S.F.C.

BALLOON

TYPE: NSC

VOL: 30,487,996 FT^3

MATL: 0.6 MIL POLY
(2) 0.7 MIL CAPS

WT: 2576 LBS

LOAD FACTORS

PAYLOAD: 1563

GROSS LD: 4139

FREE LIFT: 580

BALLAST: 600

RAVEN industries, inc.

DR.

CHK.

APPR.

1328 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
19 July 1972
Dr. R. Hartman

Weather conditions were not favorable for launching from the 14th to the 18th of July. Every afternoon light scattered showers created unstable surface conditions. Wind velocities and directions changed every twenty to thirty minutes.

On 19 July, winds remained steady at ten knots on the surface and five to eight knots at the 500 foot level. A suitable layout direction was obtainable on the ramp area. Layout of the balloon took longer than normal because the balloon had been laid out once before and put back in the box. Handling the upper 50 feet of the balloon where the protective wrapper had been opened required caution to prevent damage to the balloon. In addition, the large launch spool was somewhat cumbersome to work with.

A slight delay also resulted when Raven instrumentation was rechecked.

As inflation began, the wind was in perfect alignment with the layout, however, in twenty minutes the wind began to shift to the northeast of the layout. Prior to launch, the wind was six knots and 90° to the layout.

As a precaution to premature release, a squib cannon and nylon line were used to secure the gondola to the launch truck. If a smooth launch was not possible, the balloon and gondola could be retained.

Since winds were light, the launch was not as difficult as envisioned. The launch truck maneuvered some 300 feet to the edge of the runway where the gondola lifted free of the pin. Although the squib line was fired, it was never actually under load.

A small hitchhike experiment was mounted on top of one of the ballast hoppers. The experiment was provided via the French Embassy in Ottawa.

Ascent was normal at about 1000 fpm to the tropopause. The track was unusual in that the balloon at 40,000 feet was directly over the telemetry station.

NASA scientists became alarmed because of the weak signal and requested departure of the C-47 at 0600 hours instead of the scheduled 0900 take off. A NASA technician was sent downwind to man the NASA telemetry station at Uranium City.

The balloon, after reaching ceiling of 142,000 feet, took a southwesterly heading. The Uranium City station acquired a strong telemetry signal while the flight was ninety miles out of Churchill. Seventeen hours after launch the balloon was over Fort McMurray in a reasonable recovery area. Termination was unsuccessfully attempted by the Cessna 206 float plane so the Uranium City Center transmitted the termination command with satisfactory results.

The balloon drifted twenty miles to impact, ten miles west of Fort McMurray.

NASA scientists indicated the flight was successful. The weak signal early in the flight was attributed to low temperature--the signal strength increased to normal after the experiment warmed up.

The completion of Flight 1329 ended the 1972 Churchill series for NASA-Goddard. Two flights were scheduled later in October from Red Deer, Alberta.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1328 Director Fulkerson
2. Scientist Hartman Group GSFC Date/Time 7-20-72 / 0051 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 8⊕ 20⊕ 40°F 10 MPH SLP-1005.0 Cross Wind Angle 40°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 21,000 ft. Temp -34.0 °C Inflation Start 0010 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 650 ft.

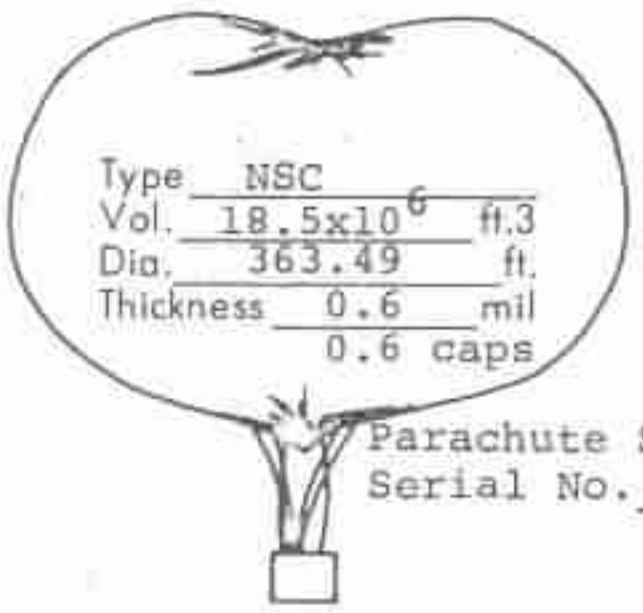
5. Balloon: Theoretical 3.06 - 2.57 Mbs. 134.2 - 138.5 K ft. How Determined? MFG Curve

Ceiling: Actual 2.1 Mbs. 143.8 K ft Transducer

6. Ascent: Surfact to Trop. 1,000 fpm Trop. to Ceiling 505 fpm
7. Flight Duration: Total 18 hrs. 35 min. At Ceiling 13 hrs. 24 min.
8. Termination: Time 1839 Z Altitude 143.0 K ft. Cause R/C - UC
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-20-72 / 1926 Z Location 111° 33' W 56° 43' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
250.7	Telemetry	20.0
149.4	Communications & Command	20.0
7465	Communications	20.0

12. Balloon: Code Number SF 363.49-060-NSC-02 Serial Number 6



WEIGHTS

Balloon	1,854
Parachute &Rigging	86
Instrumentation Raven	58
Ballast	500
Scientific Package	807
Other Biostack	4
Other Crush Pad	16
Gross Weight	3,325
Free Lift . . 14%	466
Gross Inflation	3,791
Helium used (cu. ft.)	58,760

13. Flight Failures 206 tried but could not terminate flight.
(Nature of flight failures - if any)

14. Comments Biostack Hitch Hike
(Significant factors concerning the operation)

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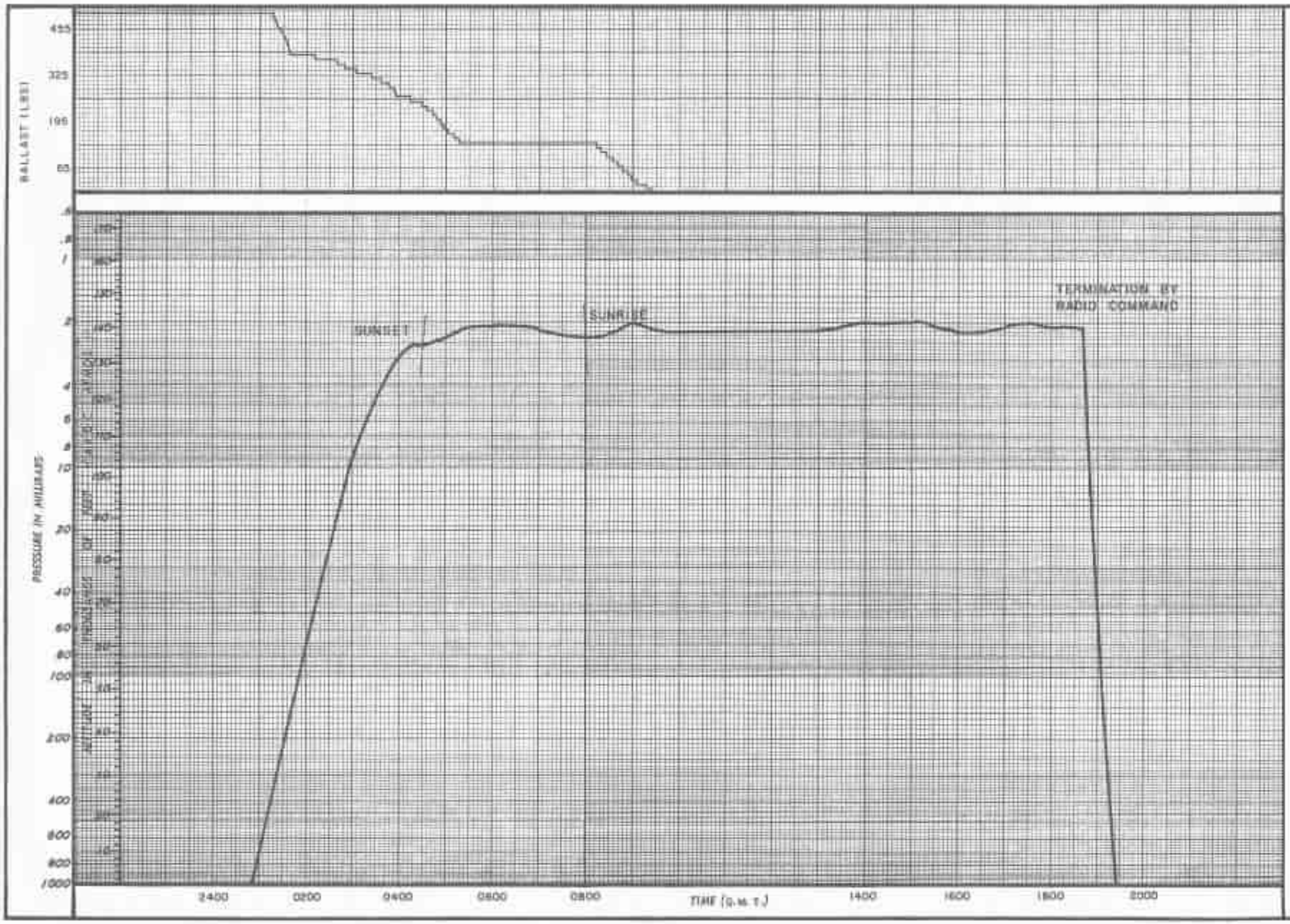
ONR/Code 421



FLIGHT NO. 1328

DATE: 20 JULY 72

FOR: N.A.S.A.-G.S.F.C.

BALLOON

TYPE: NSC

VOL: 185×10^6 FT^3

MATL: 0.6 MIL POLY
(2) 0.6 MIL CAPS

WT: 1854 LBS

LOAD FACTORS

PAYLOAD: 1471

GROSS LB: 3325

FREE LIFT: 466

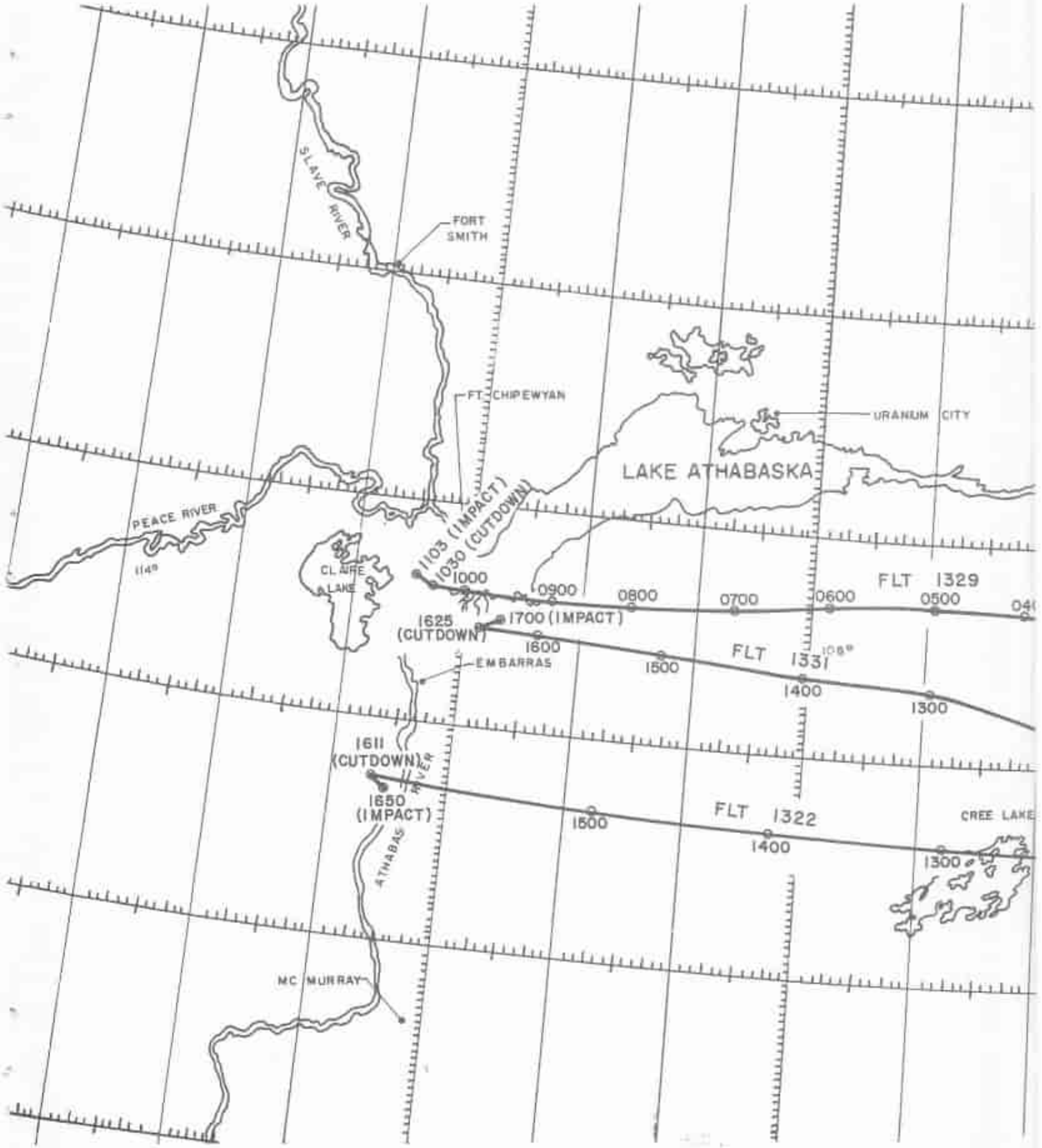
BALLAST: 500

RAVEN
industries, inc.

DR.

CHK.

APPR.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URANIUM CITY
LAKE ATHABASKA
PEACE RIVER
114°
CLAIRE LAKE
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1030 (CUTDOWN)
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1625 (CUTDOWN)
1700 (IMPACT)
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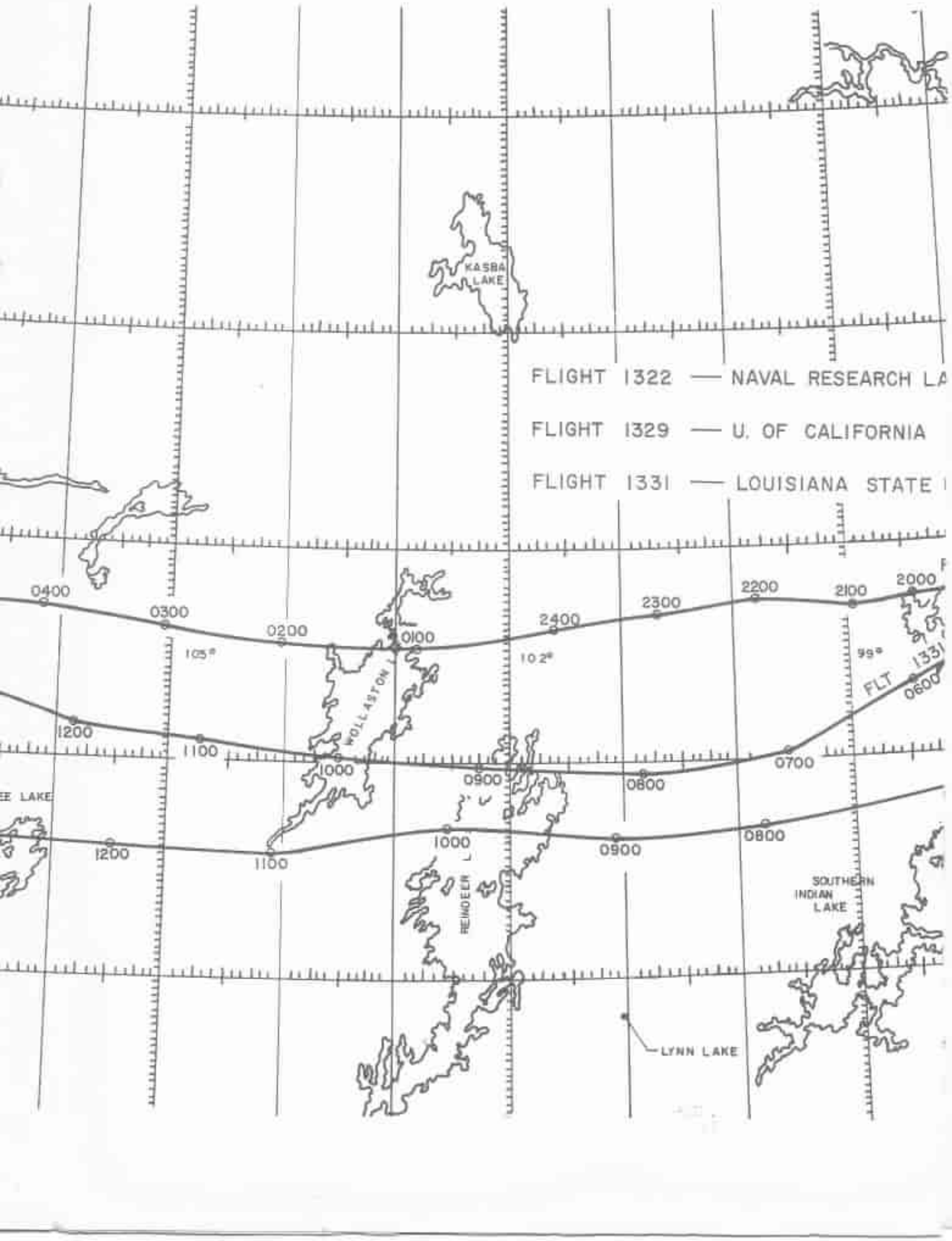
EMBARRAS
1611 (CUTDOWN)
1650 (IMPACT)
FLT 1322
CREE LAKE
MC MURRAY


KASBA LAKE
FLIGHT 1322 — NAVAL RESEARCH LA
FLIGHT 1329 — U. OF CALIFORNIA
FLIGHT 1331 — LOUISIANA STATE
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SOUTHERN INDIAN LAKE
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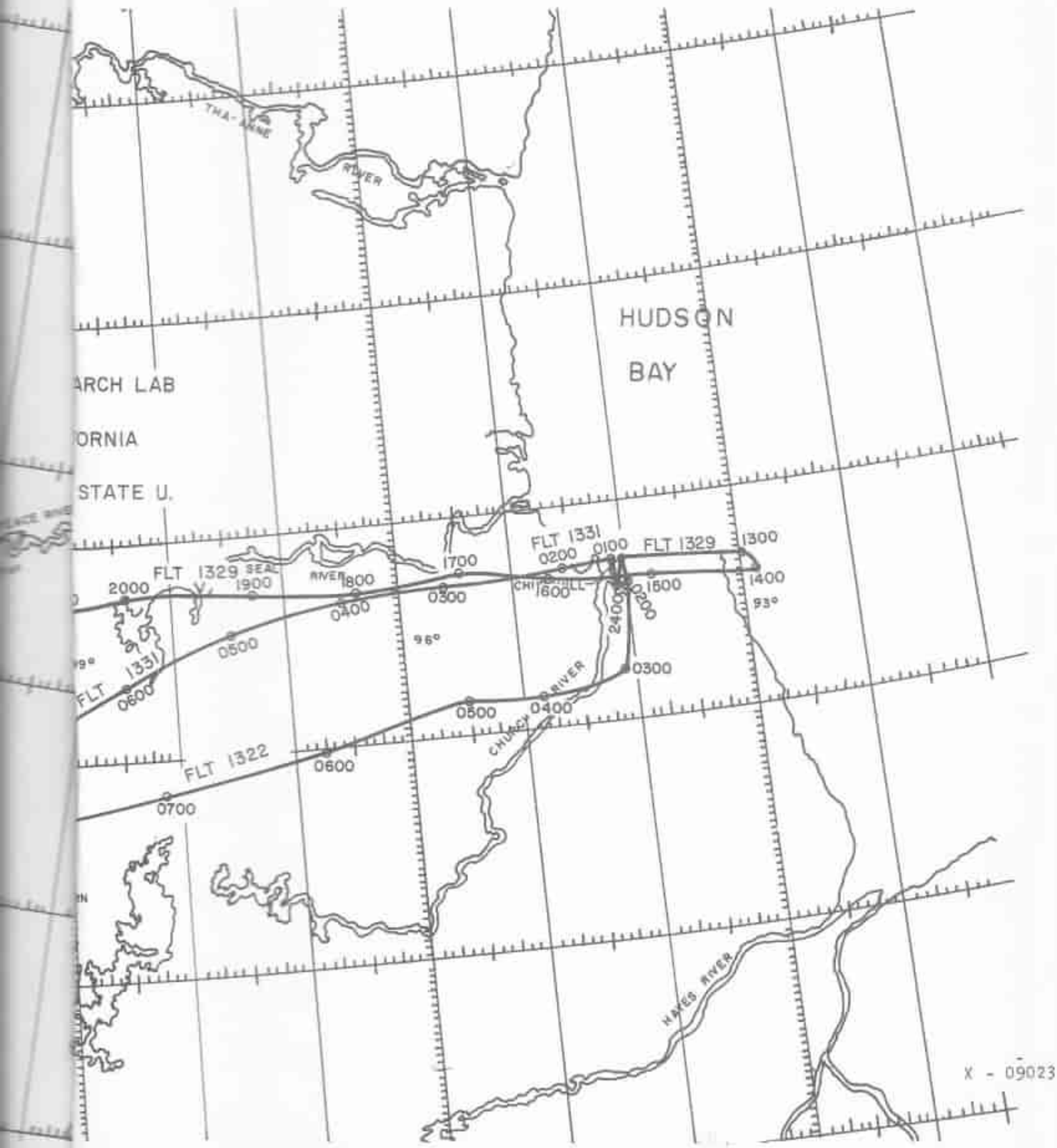
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CHURCHILL RIVER
FLT 1322
0600
0700
HAYES RIVER
X - 09023

1322 - FLIGHT DESCRIPTION

NAVAL RESEARCH LABORATORY
2 July 1972
Dr. M.M. Shapiro - H. O'Dell

The experiment consisted of four emulsion stacks arranged on a flat platform. Each stack was mounted on a pivot which allowed the stacks to be rotated 180 inches after the balloon reached ceiling. The rotation was performed by command from the Churchill Control Center.

In addition to the NRL experiment, two other plastic stacks were flown for AFCRL--these were not rotated.

The balloon selected for this flight was a 15 MCF balloon which had had a highly successful history on the Churchill Skyhook Program.

Balloon control instrumentation included the Raven TRAC^{R} package which provided telemetry data, command channels for termination, ballast experiment, rotation, and ranging.

In addition to the standard control instrumentation, a new transmitter was flown for evaluation. The tracking equipment consisted of a six-foot parabolic reflector

with a dipole feed, mounted on a "prototype" manually controlled pedestal. The dipole was connected to a band pass filter and pre-amplifier, then through 50 feet of RG-8 cable to the L-Band Tuner, plugged into a DEI TR-711 Receiver.

The overall system, when utilized with the balloon-borne 2-1/2 watt transmitter and a simple dipole transmitting antenna, was comparable in range sensitivity to the P-Band system presently in use. Problems, however, occurred as expected, with the antenna mechanical system. Too much backlash and excessive motor drive speed made "locking-on" the flight package very difficult. The beam-width of the six-foot dish is approximately 10° and requires more precise control, both in elevation and azimuth, to retain a peaked signal.

At a balloon range of 300 miles, the system sensitivity was estimated at about a 10 db signal to noise ratio. This measurement was arrived at by inserting attenuators into the antenna feed connector and determining the minimum discernible signal available.

Another problem area is with the balloon-borne transmitter efficiency. This runs about half of what was available with the 250 MHz system, thus requiring twice the battery capacity and therefore, twice the weight and cost. Added heat dissipation, along with the bigger battery volume, will also require some design of the instrument package.

The system shows promise and with additional effort, should be as functional as the old P-Band system.

Launch was performed in a smooth manner using the dynamic launch at 0123. The launch truck moved approximately fifty feet during a seven knot wind. Ascent began at 850 fpm to ceiling. Ballast was expended every 15 minutes.

The balloon floated low during the early part of the flight, however, as the sun came up, the balloon began a steady ascent until it reached its theoretical ceiling. The Rosemount transducer indicated a higher level than theoretical.

After a total flight time of 15 hours and 17 minutes, of which 9 hours and 11 minutes were at ceiling, the flight was terminated by radio command from the C-47. The helicopter and Cessna 206 performed the recovery after which the gondola was returned to Embarras for transfer to Churchill aboard

the C-47. The C-47 delivered the gondola back to Churchill less than 28 hours after launch.

NRL scientists packed the experiment for shipment and departed Churchill on 4 July.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1322 Director Fulkerson
2. Scientist Shapiro/O'Dell Group NRL Date/Time 7-3-72/ 0123 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 200 -Φ 46°F 350° 8 MPH SLP-1024.8 Cross Wind Angle 10°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 36,000 ft. Temp -52.0 °C Inflation Start 0050 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.

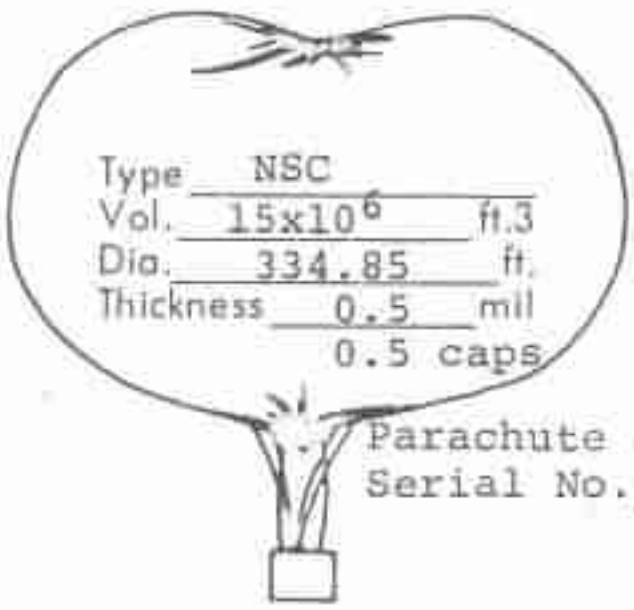
5. Balloon: Theoretical 1.81 - 1.56 Mbs. 147.8 - 151.8 K ft. How Determined? MFG Curve

Ceiling: Actual 1.5 Mbs. 152.8 K ft Transducer

6. Ascent: Surfact to Trop. 818 fpm Trop. to Ceiling 520 fpm
7. Flight Duration: Total 15 hrs. 27 min. At Ceiling 10 hrs. 25 min.
8. Termination: Time 1611 Z Altitude 152.8 K ft. Cause R/C C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-3-72/ 1650 Z Location 111° 32' W 57° 42' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
253.8	Telemetry	16.0
149.4	Communications & Command	16.0
7465	Communications	16.0

12. Balloon: Code Number SF 334.85-050-NSC-03 Serial Number 30



WEIGHTS

	Balloon	1,245
	Parachute & Rigging	32
Timers &	Instrumentation Raven	58
	Ballast	250
	Scientific Package	190
	Other Fukui	16
Raven	Other Xmitter & Batt.	23
	Gross Weight	1,814
	Free Lift 13%	236
	Gross Inflation	2,050
	Helium used (cu. ft.)	31,775

13. Flight Failures
(Nature of flight failures - if any)
14. Comments Hitch Hikes for Fukui #4 and #6.
(Significant factors concerning the operation)

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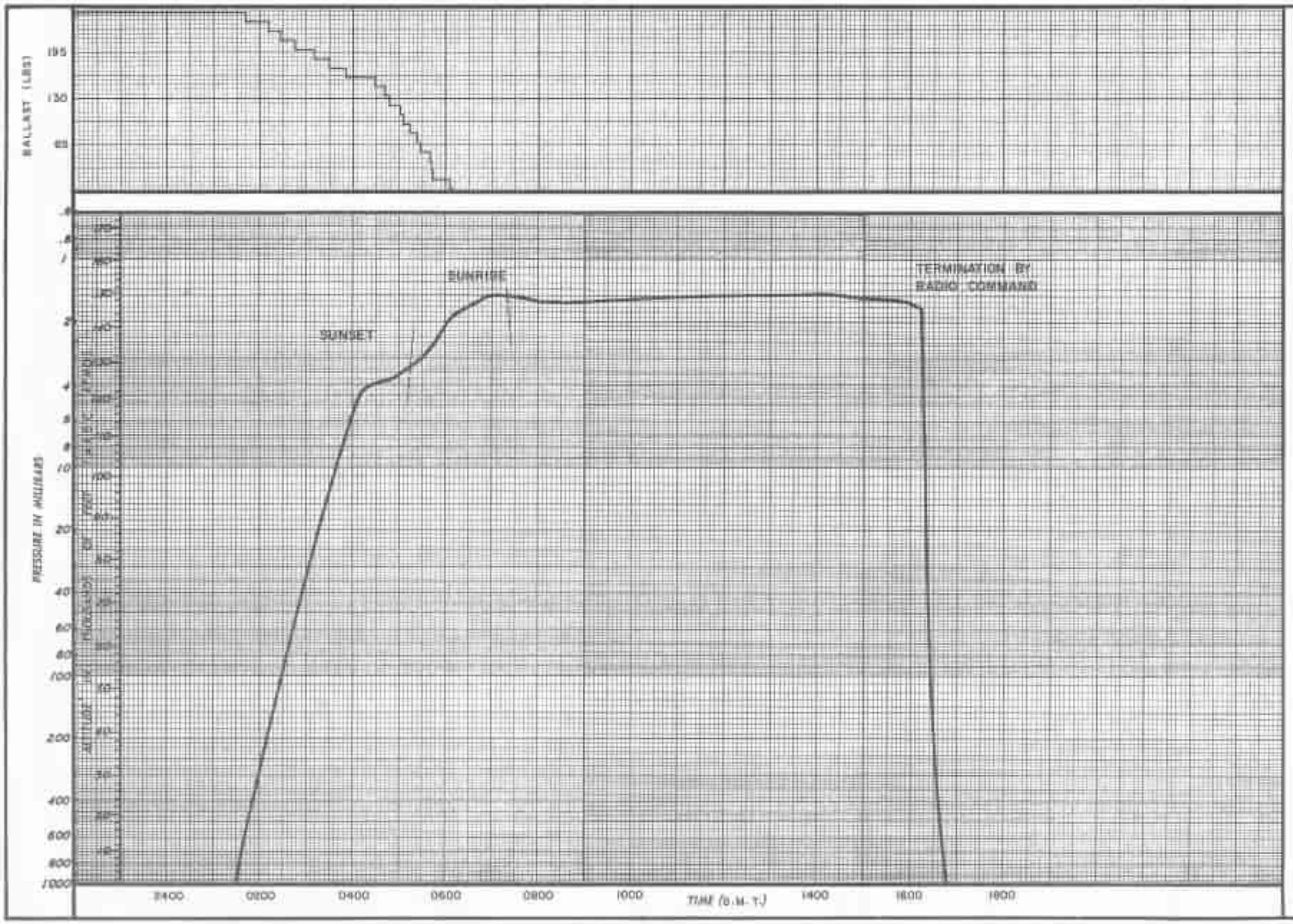


FLIGHT NO. 1322

DATE: 3 JULY 72

FOR: NAVAL RESEARCH LAB

BALLOON

TYPE: N5C

VOL: 15×10^6 FT^3

MAT'L: 0.5 MIL POLY (2) 0.5 MIL CAPS

WT: 1245 LBS

LOAD FACTORS

PAYLOAD: 569

GROSS LIFT: 1814

FREE LIFT: 236

BALLAST: 250

RAVEN industries, inc.

DR.

CHK.

APPR.

1329 - FLIGHT DESCRIPTION

UNIVERSITY OF CALIFORNIA - RIVERSIDE
22 July 1972
Dr. R. White

The largest and heaviest experiment ever flown from Fort Churchill was scheduled for a single flight, with a reflight from Cape Girardeau, Missouri, or Sioux Falls, South Dakota, in early September.

Since the weight of this experiment exceeded the lifting capability of the helicopter, it was necessary to disassemble the experiment into several pieces which could then be flown out separately. In addition, the assembled gondola was too large to load into the C-47. It could, however, be loaded in pieces. Because of the special recovery considerations, two University of California personnel were scheduled to go on recovery to perform disassembly in the field. After the gondola was recovered and flown to the nearest airport to be loaded in the C-47, it was to be taken to the Pas, Manitoba, to be loaded into the University of California van for its return to the United States.

Rigging the experiment with the necessary ballast hoppers and balloon control instrumentation presented a problem. The experiment "looked" up and down and out, with only a 28" space around the center of the gondola, where hoppers and instruments could be placed.

An aluminum bracket was fabricated and clamped to the gondola cover with cables and turn buckles. Portions of the bracket were long enough to extend through the 6" thick styrofoam insulation. The control instrument canister was attached with four bolts, becoming a rigid member of the gondola.

Two ballast hoppers, of 250 pound capacity each, were suspended on cables from the main suspension harness. Twelve hundred pound nylon circumferential bands were used to hold the hoppers against the side of the gondola. Cardboard deflectors attached to each hopper allowed expended ballast to clear the shock pad which extended beyond the ballast hoppers. Timers and battery packs were mounted on each hopper.

Standard Raven instrumentation was used for the flight, with the addition of a second transmitter to provide scientific data telemetry. Scientific data was recorded at Fort Churchill and at Uranium City.

The "Riverside" detector measures the neutron energy spectrum in the interval 5-100 MeV and also obtains information on the direction of the incoming neutron. The neutron is detected through a double scatter of hydrogen in each of two 75 liter liquid scintillator tanks which are completely enclosed in active anticoincidence shields. Energy determination is from a combination of pulse-height analysis of the light produced in the liquid scintillators by recoil hydrogen nuclei and a time-of-flight analysis of the scattered neutron's trajectory between the tanks. Each tank is optically divided into eight cells viewed by separate photomultiplier tubes to define this trajectory. The detector has a full directional capability so that a search for solar neutrons can be realized from a study of the downward component in addition to measuring the upward or albedo neutron intensity. These are the principal objectives of the experiment. The instrument also has a number of time sharing modes so that the combination of large area and thick and thin scintillators can be exploited. For example, at night when solar neutrons are not detectible, gamma rays and multiple charged nuclei are studied. Certain logic events are monitored sequentially throughout the flight. The most useful of these is a low energy gamma ray rate which has time resolution to better than 1 msec; this enables a search for pulsars to be made above 1 MeV without a sensitive directional capability.

On 21 July, weather was excellent. The University of California gondola was ready for launch, however, two balloons launched previously were still in very close range and could have caused telemetry problems so the launch was delayed for six hours. Winds aloft, as determined by the two previous flights, were light so the timers were set for 26 hours. On the morning of 22 July, under light winds of three knots, the flight was launched with perfect timing.

Ascent was slower than scheduled, so ballast was expended to increase the rate. A free lift of 14%, with a daytime ascent, normally produces 800 to 1000 feet. A check of the helium trailer revealed one cylinder was still full. The valve was difficult to open by hand.

After drifting 40 miles east over Hudson Bay, the balloon began its westerly tract reaching ceiling directly over Fort Churchill.

The flight was terminated by the Uranium City Center after 19 hours at ceiling. The gondola descended from 126,000 feet in 38 minutes, landing 15 miles southwest of Fort Chipawan, Saskatchewan. Impact was in a marsh too shallow for boats

and too deep to wade in. Recovery required two days.

Two natives with boats and outboard motors towed the package 15 miles to the Fort Chipawan dock where it was hoisted up on land and dismantled into units which could be handled by the crew.

Condition of the gondola was not immediately determined but appeared to be in good condition.

The experiment was very successful and scientists planned a reflight to be made in September from Cape Girardeau, Missouri. The experiment was taken to Sioux Falls, where a University of California technician performed a complete checkout and found the instrument in perfect working order.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1329 Director Vandersnick
2. Scientist White Group U of California Date/Time 7-22-72/ 1153 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 250 -Ø 54°F Calm SLP-1018.2 Cross Wind Angle 0°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 35,000 ft. Temp -5.2 °C Inflation Start 1125 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 600 ft.

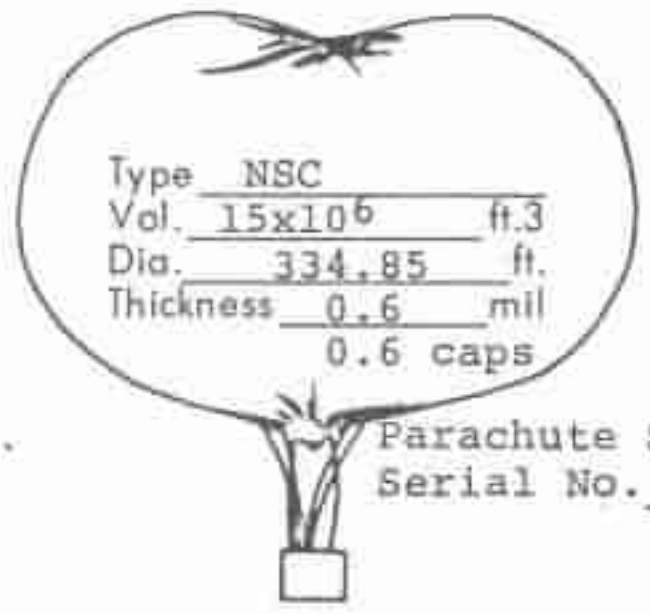
5. Balloon: Theoretical 3.65 - 3.31 Mbs. 129.5 - 132.0 K ft. How Determined? MFG Curve

Ceiling: Actual 3.3 Mbs. 132.1 K ft Transducer

6. Ascent: Surfact to Trop. 765 fpm Trop. to Ceiling 606 fpm
7. Flight Duration: Total 23 hrs. 10 min. At Ceiling 19 hrs. 24 min.
8. Termination: Time 1030 Z Altitude 132.0 K ft. Cause R/C - UC
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-23-72/ 1103 Z Location 111° 30' W 58° 37' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
253.8	Telemetry	24.0
149.4	Communications & Command	24.0
7465	Communications	24.0

12. Balloon: Code Number SF 334.85-060-NSC-05 Serial Number 31



WEIGHTS

Balloon	1,689
Parachute & Rigging	92
Timer & Instrumentation Raven	58
Ballast	400
Scientific Package	1,370
Other Ex-Batteries	20
Other Crush Pad	30
Gross Weight	3,659
Free Lift 14%	512
Gross Inflation	4,171
Helium used (cu. ft.)	64,650

13. Flight Failures
(Nature of flight failures - if any)

14. Comments Fukui Hitch Hike #1 & #3 (Not recovered) water impact.
(Significant factors concerning the operation)

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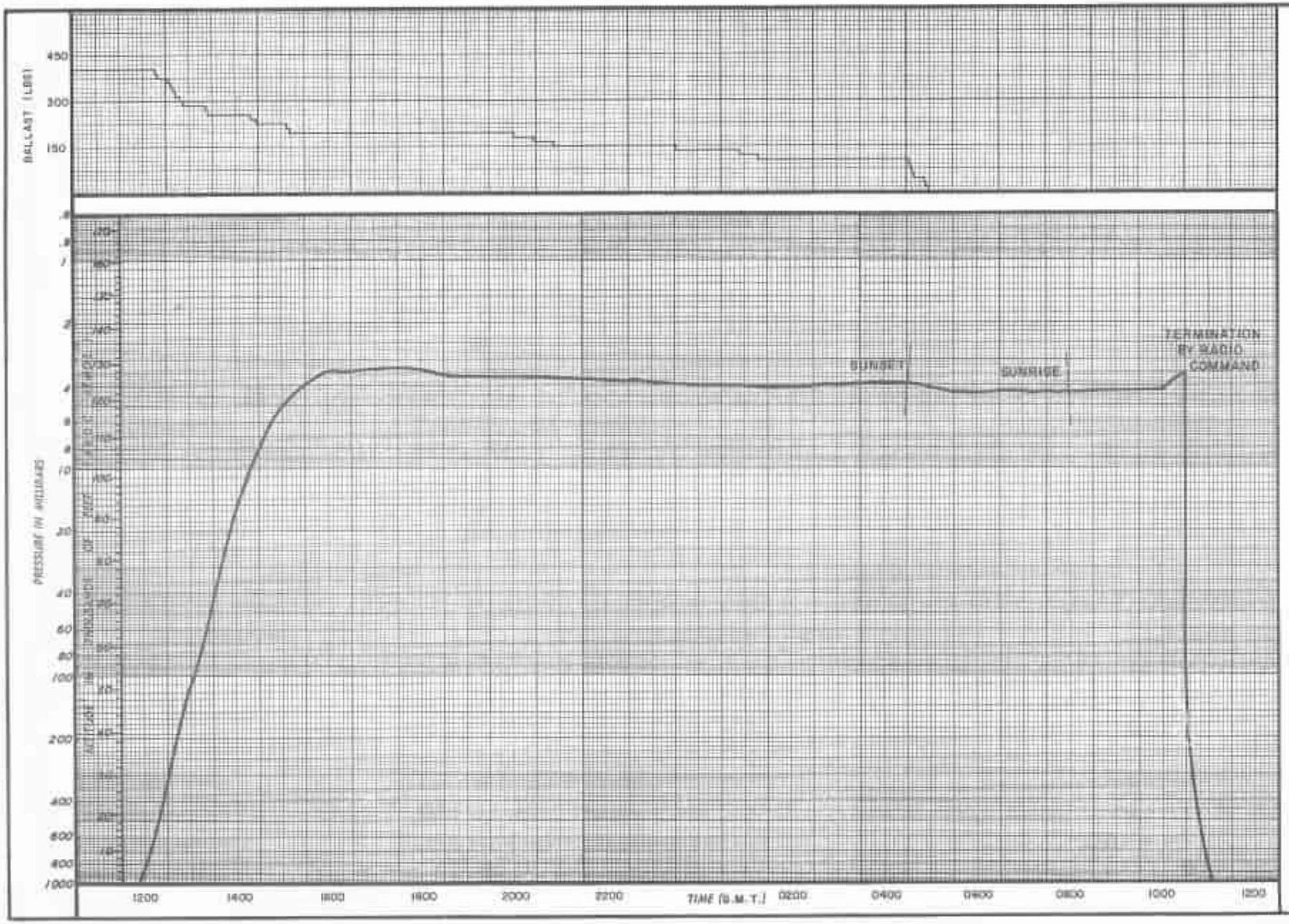
ONR/Code 421



FLIGHT NO. 1329

DATE: 22 JULY 72

FOR: U OF CALIF

BALLOON

TYPE: NSC

VOL: 15×10^6 FT^3

MATL: 0.6 MIL POLY
(2) 0.6 MIL CAPS

WT: 1689 LBS

LOAD FACTORS

PAYLOAD: 1970

GROSS LD: 3659

FREE LIFT: 512

BALLAST: 400

RAVEN industries, inc.

DR.

CHK.

APPR.

R-0473002

1331 - FLIGHT DESCRIPTION

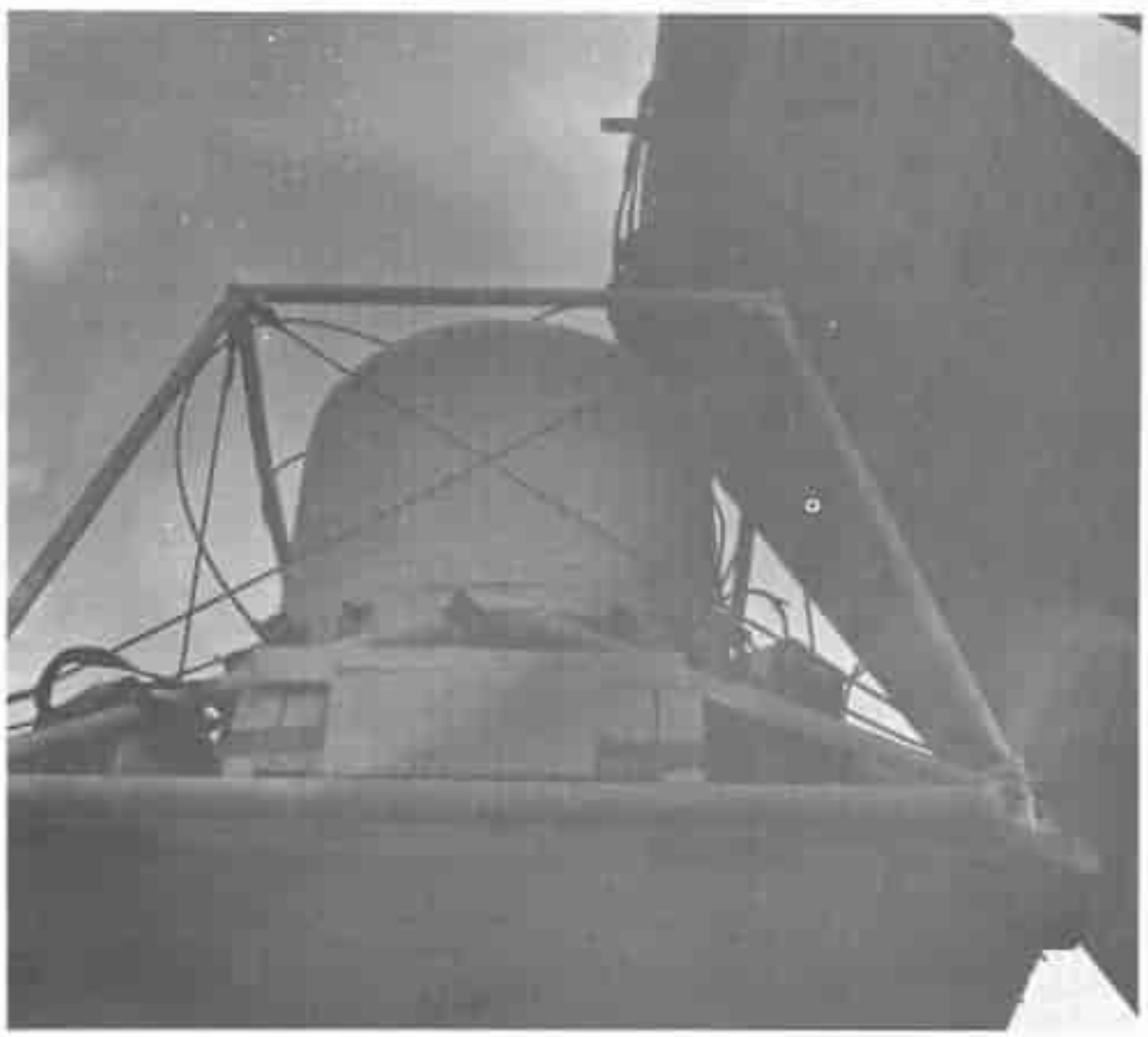
LOUISIANA STATE UNIVERSITY
24 July 1972
Dr. S. Verma

The Louisiana State University experiment was scheduled for its first flight on the 1972 Skyhook Program, a prototype which was actually completed after arriving at Fort Churchill.

This experiment was a charged particle telescope consisting of plastic scintillators, a lucite Cerenkov detector, lithium drifted silicon detectors, cesium iodide detectors, and an optical spark chamber. It was designed for the study of the charge composition, isotopic composition, and energy spectra of primary cosmic ray nuclei with charge ranging from 2 to 8. Data consisted primarily of pulse height information obtained from various detectors and charged particle tract information obtained from the optical spark chamber. All data was recorded on board by means of magnetic tape and 16mm movie camera.

This was another small experiment by physical measurements, however, when attachment of power supplies, photo barographs, and the support frame were accomplished, the gondola weighed in at near 693 pounds.

The launch was delayed 24 hours. Wind direction was favorable for a layout on the east-west runway, and velocity was steady at six knots. Inflation was performed in 13 minutes. After inflation was complete and last minute preparations being made to release the balloon, surface winds shifted 30° and increased to twelve knots. Launch was delayed about 15 minutes. Finally, during a lull, the balloon was released. The horizontal speed exceeded the virtual speed, which required moving the launch truck quickly to impart some load into the lower part of the balloon which was slack and being drug off the ground cloth. The timing was no less than perfect, with the balloon being fully decelerated several seconds before lifting the gondola off the pin.



The large tubular framework about the gondola provided easy positioning of control instruments, ballast hoppers, and possible hitchhikes.

Taking a southerly trajectory during a normal ascent, the flight managed to reach ceiling without going out over the bay.

Professor Verma and his associates were very happy with the first flight of their experiment. The flight remained at a ceiling of 132,000 feet for just over thirteen hours.

The flight was terminated by the Cessna 206 aircraft and landed 37 minutes later twenty miles southeast of Fort Chipeywan.

While not being too heavy for the recovery helicopter to lift, it was too large to go into the C-47 without disassembly. A special box was constructed of plywood so the gondola could be placed in it for transporting it back to Churchill.

The experiment was stripped down to the basic gondola shell and taken to Fort Chipeywan, while the Cessna 206 carried parachutes and instrumentation.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1331 Director Fulkerson
2. Scientist Verma Group Louisiana State U Date/Time 7-24-72/ 2327 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 500 90⊖ 47°F 050° 13 MPH SLP-1019.8 Cross Wind Angle 10°
   (Sky-Temp-Wind-Pressure)

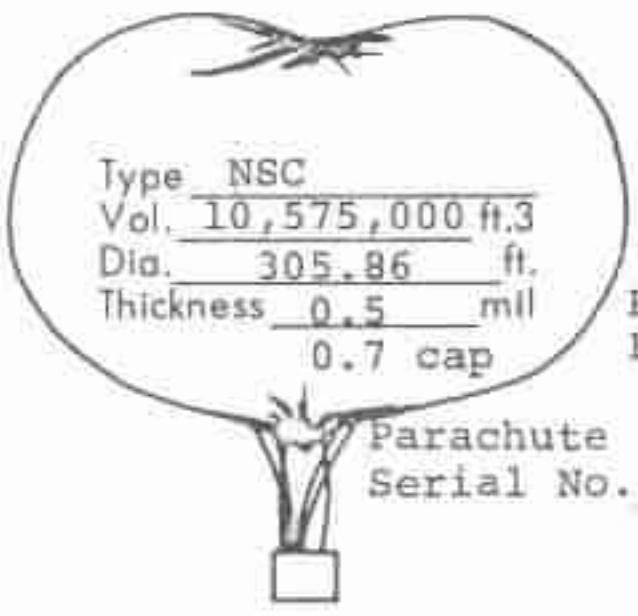
   Trop (Coldest) Ht. 35,000 ft. Temp -57.0 °C Inflation Start 2300 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 450 ft.
5. Balloon: Theoretical 3.07 - 2.78 Mbs. 133.9 - 136.5 K ft. How Determined? MFG Curve

   Ceiling: Actual 2.8 Mbs. 136.3 ft Transducer
6. Ascent: Surfact to Trop. 972 fpm Trop. to Ceiling 635 fpm
7. Flight Duration: Total 17 hrs. 35 min. At Ceiling 13 hrs. 54 min.
8. Termination: Time 1625 Z Altitude 136.0 K ft. Cause R/C - UC
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-25-72/ 1702 Z Location 110° 42' W 58° 28' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
250.7	Telemetry	18.0
149.4	Communications & Commands	18.0
7465	Communications	18.0

12. Balloon: Code Number SF 305.86-050-NSC-21 Serial Number 414



WEIGHTS

Balloon	1,031
Parachute &Rigging	53
Instrumentation Raven	58
Ballast	200
Scientific Package	693
Other Crush Pad	20
Other L-Band Xmitter	29
Gross Weight	2,084
Free Lift	292
Gross Inflation	2,376
Helium used (cu. ft.)	36,828

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Fukui Hitch Hike #2 & #5
    (Significant factors concerning the operation)

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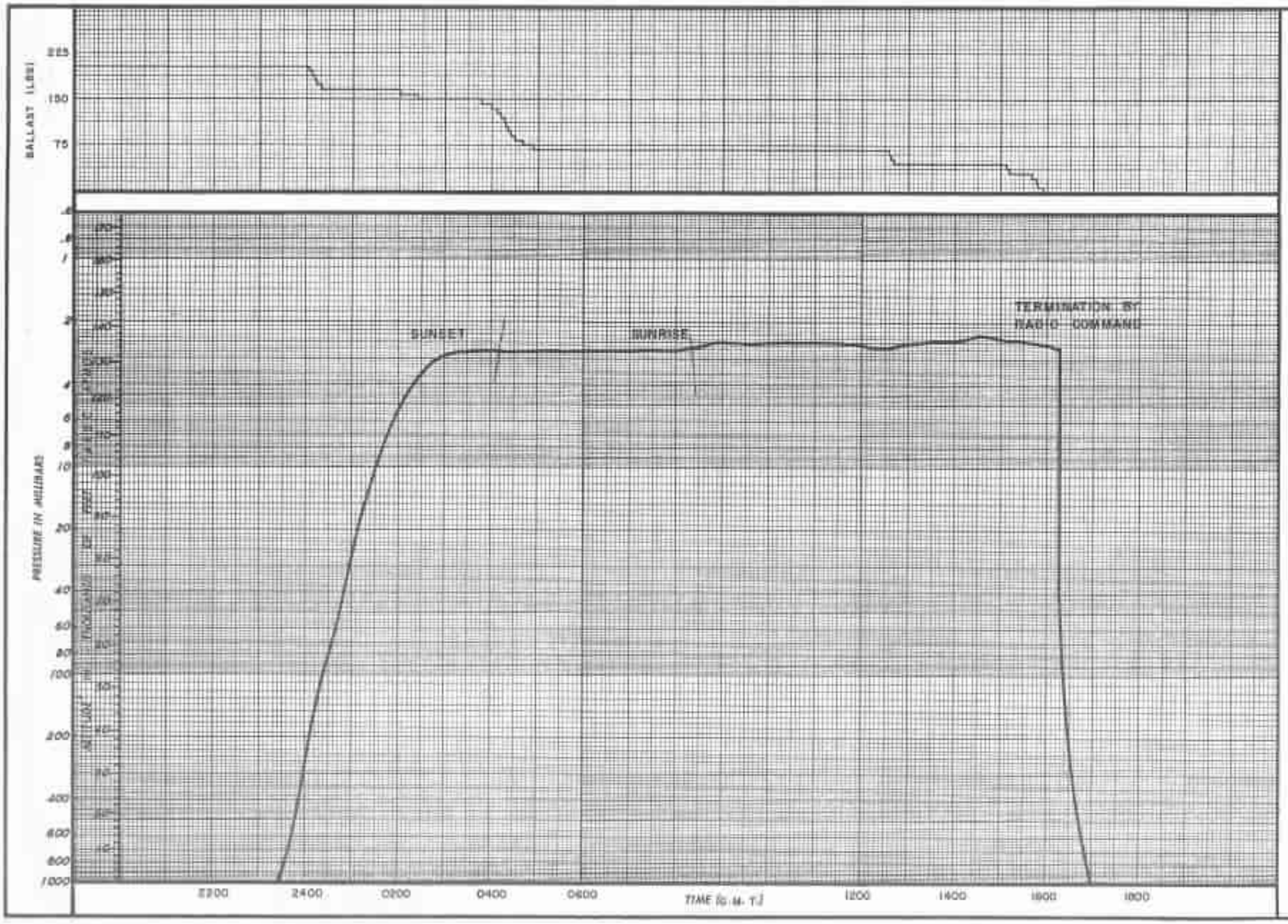


FLIGHT NO. 1331

DATE: 24 JULY 72

FOR: LOUISIANA STATE U

BALLOON

TYPE: N5C

VOL: 10,575,000 FT^3

MATL: 0.5 MIL POLY
0.7 MIL CAP

WT: 1031 LBS

LOAD FACTORS

PAYLOAD: 1053

GROSS LD: 2084

FREE LIFT: 292

BALLAST: 200

RAVEN industries, inc.

DR.

CHK.

APPR.

R-0473002

1324 - FLIGHT DESCRIPTION

UNIVERSITY OF NEW HAMPSHIRE
4 July 1972
Dr. W. Webber - B. Evans

Two flights were scheduled, each with a different experiment. The experiment on Flight 1324 was a large area cosmic ray telescope for the study of cosmic ray charge and isotope composition in the range Z=1-26. The telescope consists of a Cerenkov counter to measure the particle's velocity, two scintillation counters to measure the particle's de/dx, a total E counter, followed by a third scintillator. A comparison of the outputs of the various counters permits the determination of the particle's charge and energy and of its mass as well over the range of energies for which the particles stop in the E detector. The experiment was similar to the flight of 1970 and 1971 but with the addition of a new total E counter for isotope resolution.

Scientific data is telemetered by a separate data link monitored by the personnel from the University of New Hampshire. A secondary telemetry center was available at Uranium City, however, this station was not used for this flight.

Similar to previous flights, the experiment was contained in a cylinder 30 inches in diameter, approximately 7 feet tall, and affixed to a tubular frame which provides attachment points for ballast hopper, control instrumentation, and crush pad. The construction of the frame also provided some degree of shock absorption for landing.

A smaller experiment belonging to Dr. Hugh Anderson of Rice University, Houston, Texas, was flown as a hitchhike. The experiment was enclosed in a 2x2x3 foot styrofoam box. Objective of the experiment was to measure total cosmic ray ionization rate as a function of local time at floating altitude. Data was telemetered through the Raven data link and recorded on tape.

The balloon provided for this flight was a 10.6 MCF, 0.7 mil, with a 0.7 mil single cap.

The flight gondola weighed 912 pounds; 300 pounds of which was expendable ballast contained in two separate hoppers, with a combined drop rate of 27 pounds per minute. A 49 foot parachute provided an impact velocity of 23 fps.

Launch was smooth during a nine knot surface wind with 10° cross component.

Using a 14% free lift (307 pounds), the balloon ascended at 1000 fpm from launch to 80,000 feet, with several ballast drops near the tropopause (36,000 feet, -61°). Floating altitude was 2.7 mbs (137,000 feet).

After floating 14 hours and 40 minutes, the flight was terminated by the Cessna 206 float plane, with impact occurring 44 minutes later. The Anderson experiment was damaged to such an extent that it was shelved for the rest of the program, however, a secondary experiment was prepared for the next flight.

The New Hampshire experiment performed flawlessly throughout the flight.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1324 Director Reid
2. Scientist Webber Group U of N. Hampshire Date/Time 7-4-72/ 0856 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 50@ 80@ 2000 48°F 025° 11 MPH SLP-1025.2 Cross Wind Angle 10°
(Sky-Temp-Wind-Pressure)

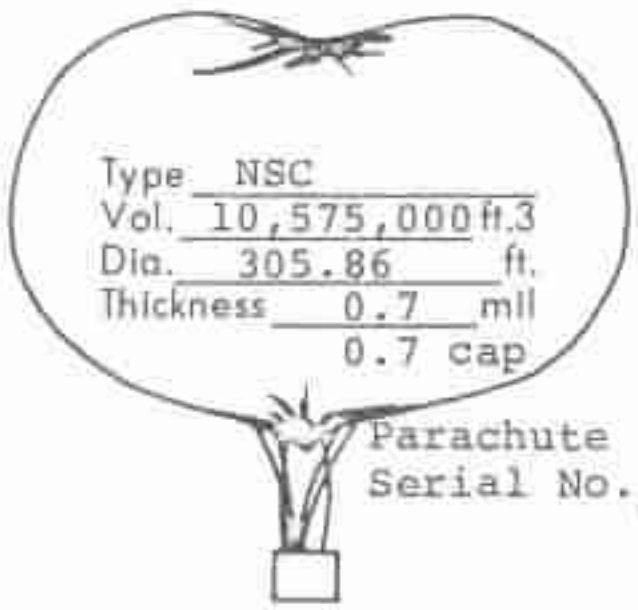
Trop (Coldest) Ht. 36,000 ft. Temp -61.0 °C Inflation Start 0730 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 500 ft.

5. Balloon: Theoretical 3.2 - 2.76 Mbs. 132.9 - 136.7 K ft. How Determined? MFG Curve
Ceiling: Actual 2.7 Mbs. 137.0 K ft Transducer
6. Ascent: Surfact to Trop. 947 fpm Trop. to Ceiling 821 fpm
7. Flight Duration: Total 18 hrs. 06 min. At Ceiling 14 hrs. 42 min.
8. Termination: Time 0218 Z Altitude 137.0 K ft. Cause R/C - 206
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-5-72/ 0302 Z Location 111° 52' W 57° 03' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
248.6	Telemetry	19.0
149.4	Communications & Command	19.0
7465	Communications	19.0

12. Balloon: Code Number SF 305.86-070-NSC-20 Serial Number 412



WEIGHTS

Balloon	1,284
Parachute & Rigging	53
Instrumentation Raven	58
Ballast	300
Scientific Package	442
Other Anderson	25
Other Crush. Pad	34
Gross Weight	2,196
Free Lift . . 14%	307
Gross Inflation	2,503
Helium used (cu. ft.)	38,796

13. Flight Failures
(Nature of flight failures - if any)

14. Comments Anderson Hitch Hike
(Significant factors concerning the operation)

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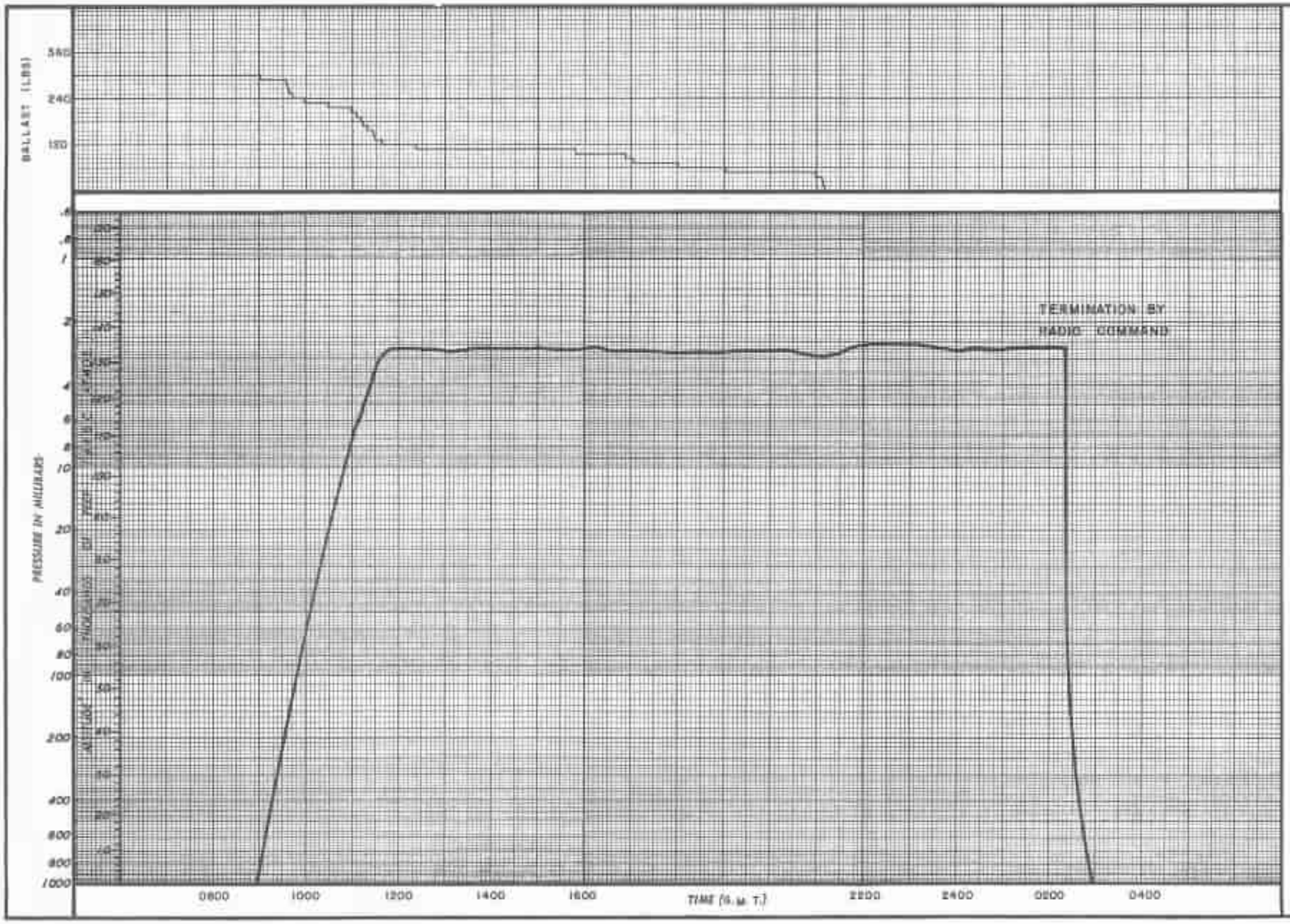


FLIGHT NO. 1324

DATE: 4 JULY 72

FOR: U OF N.HAMPSHIRE

BALLOON

TYPE: NSC

VOL: 10,575,000 FT^3

MATL: 0.7 MIL POLY
0.7 MIL CAP

WT: 1284 LBS

LOAD FACTORS

PAYLOAD: 912

GROSS LD: 2196

FREE LIFT: 307

BALLAST: 300

RAVEN industries, inc.

DR.

CHK.

APPR.

R-0473002

1326 - FLIGHT DESCRIPTION

UNIVERSITY OF NEW HAMPSHIRE
8 July 1972
Dr. W. Webber

From all outward appearances, this experiment looked the same as Flight 1324, however, the experiment was an eight element telescope designed to measure the electron spectrum from 2 MeV to 10 BeV, the positron spectrum from 2-50 MeV (using the 0.5 MeV anilation line), as well as the spectrum of protons, deutrons, He^3 and He^4. The telescope has a geometrical factor of about 60 cm^2. It includes a gas Cerenkov detector, a plastic total E counter, a NaI total E counter, a Pb glass Cerenkov total E counter, as well as four scintillation counters to measure the particle's de/dx. The telescope is an extensively modified version of the one flown in 1971.

The Anderson experiment was attached differently to help minimize impact damage. While surface winds were of reasonable velocities, the direction was quite variable. Layout was made on the northeast side of the ramp. Inflation and checkout proceeded normally. Prior to release, the wind shifted 90°.

As the balloon was released, the bubble moved swiftly to one side making it impossible for the launch truck to position the gondola directly under it. The launch truck moved slowly forward to prevent the balloon from pulling off the gondola. Before the launch truck could turn away from the balloon, the gondola was pulled off. The angle was too low to lift the gondola, and it fell to the ground striking obstructions near the edge of the runway.

At the moment of impact the termination squibs fired, the balloon.

The balloon ascended into the clouds and was no longer visible. Churchill radar was alerted, and the Office of Naval Research C-47 was sent aloft. Moments later, the balloon was spotted on the ground east of Churchill.

The New Hampshire gondola sustained serious damage on the top portion. Battery packs secured to the bottom had been dislodged and shorted, causing an electrical fire which was quickly extinguished with a dry powder type extinguisher.

Completely disassembled for checking and cleaning, the instrument was ready for reflight on 13 July.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1326 Director Fulkerson
2. Scientist Webber Group U of N. Hampshire Date/Time 7-8-72 / 0150 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 500 80@ 250@ 61°F 7 MPH SLP-1013.8 Cross Wind Angle 40°
   (Sky-Temp-Wind-Pressure)

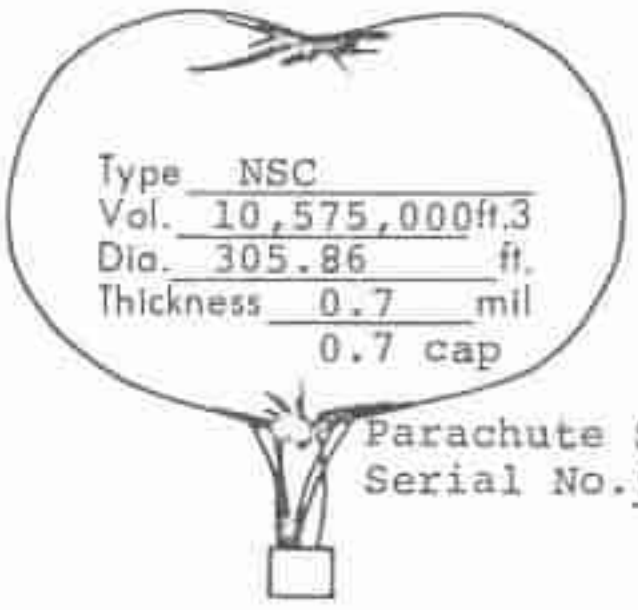
   Trop (Coldest) Ht. --- ft. Temp --- °C Inflation Start 0120 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.
5. Balloon: Theoretical --- Mbs. --- ft. How Determined?

   Ceiling: Actual --- Mbs. --- ft ---
6. Ascent: Surfact to Trop. --- fpm Trop. to Ceiling --- fpm
7. Flight Duration: Total -- hrs. -- min. At Ceiling -- hrs. -- min.
8. Termination: Time --- Z Altitude --- ft. Cause ---
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-8-72/ 0151 Z Location Launch Area
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
253.8	Telemetry	2.0
149.4	Communications & Command	2.0
7465	Communications	2.0

12. Balloon: Code Number SF 305.86-070-NSC-20 Serial Number 413



WEIGHTS

Balloon	1,268
Parachute &Rigging	54
Timer& Instrumentation Raven	58
Ballast	300
Scientific Package	667
Other Crush Pad	33
Other	
Gross Weight	2,380
Free Lift . 14%	333
Gross Inflation	2,713
Helium used (cu. ft.)	42,051

13. Flight Failures Ground abort.
    (Nature of flight failures - if any)
14. Comments Wind shift during inflation.
    (Significant factors concerning the operation)

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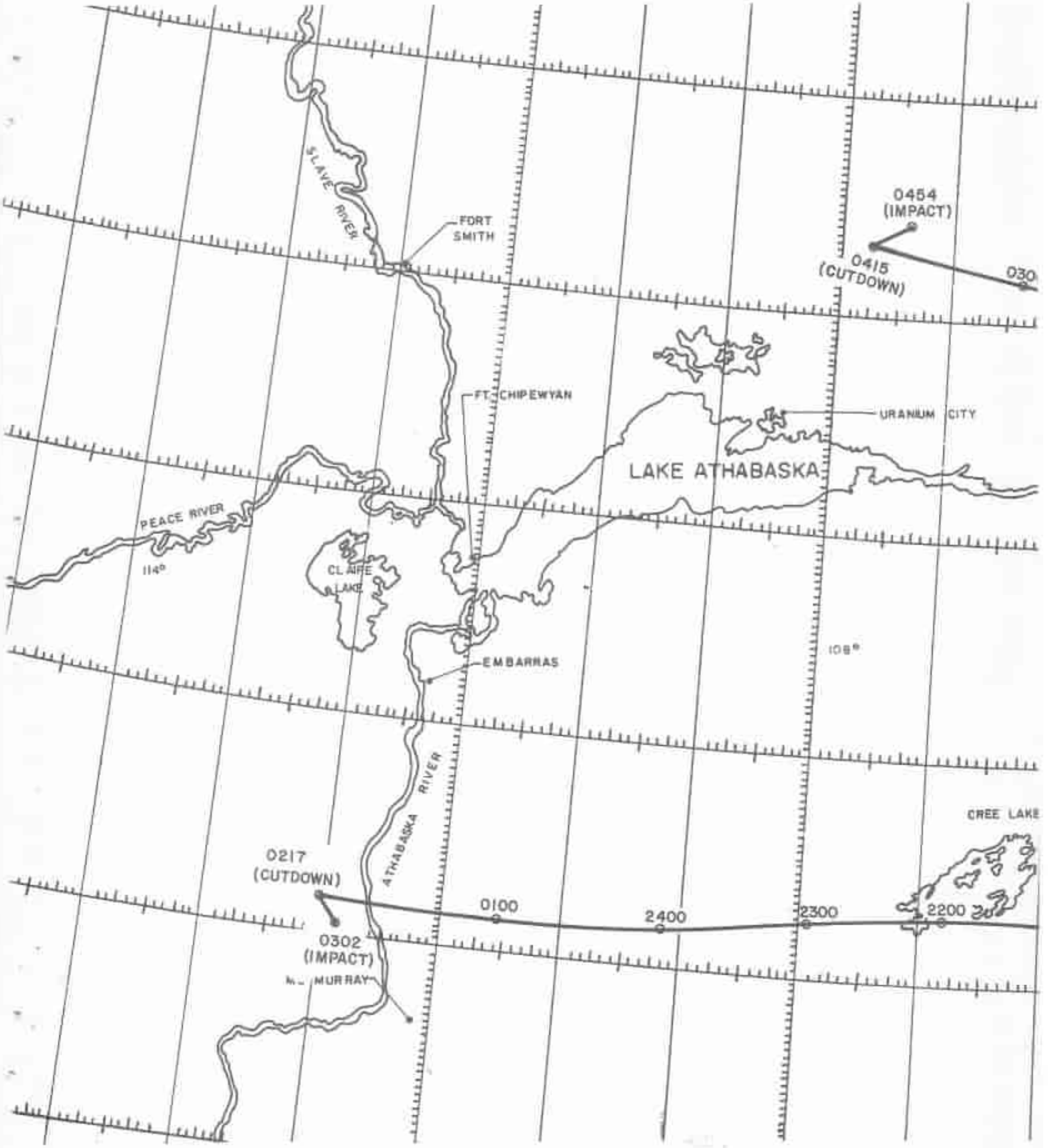

SLAVE RIVER
FORT SMITH
0454
(IMPACT)
0415
(CUTDOWN)
030
FT. CHIPEWYAN
URANIUM CITY
LAKE ATHABASKA
PEACE RIVER
114°
CLAIRE LAKE
EMBARRAS
108°
ATHABASKA RIVER
CREE LAKE
0217
(CUTDOWN)
0100
2400
2300
2200
0302
(IMPACT)
MURRAY

FLIGHTS 1324 & 1327

U. OF NEW HAMPSHIRE

KASBA LAKE

0300 0200 0100 2400 2300 2200 2100

FLT 1327

105° 102° 99°

WOLLASTON LAKE

REEREE LAKE

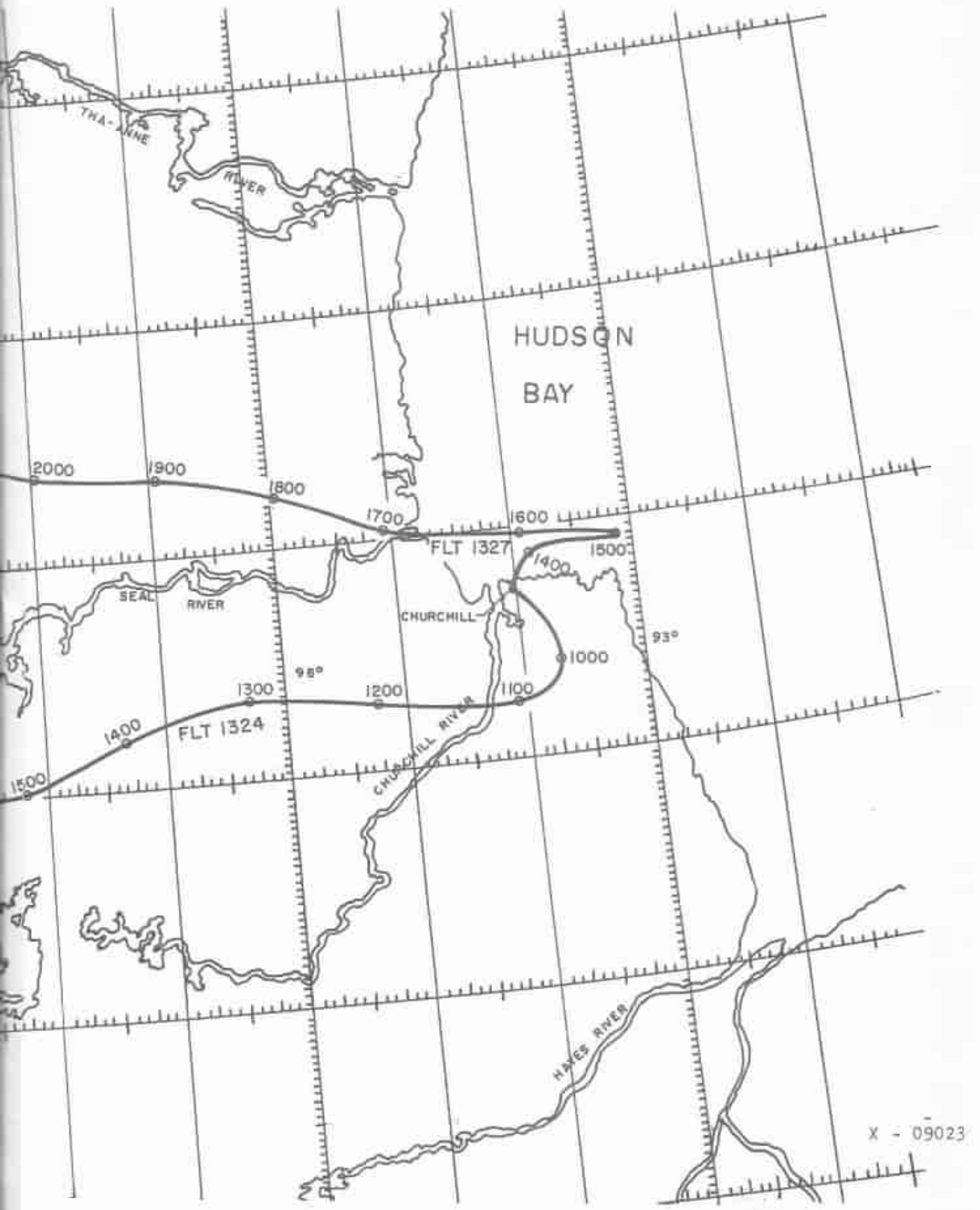
1600 1700 1800 1900 2000 2100

FLT 1324

REINDEER LAKE

SOUTHERN INDIAN LAKE

LYNN LAKE


THA-ANNE
RIVER
HUDSON
BAY
2000
1900
1800
1700
1600
FLT 1327
1500
1400
SEAL
RIVER
CHURCHILL
93°
1000
95°
1300
1200
1100
1400
FLT 1324
1500
CHURCHILL RIVER
HAYES RIVER
X - 09023

1327 - FLIGHT DESCRIPTION

UNIVERSITY OF NEW HAMPSHIRE
14 August 1972
Dr. W. Webber

Favorable surface winds permitted launching on 14 July. The launch was perfect in a five knot, 20° cross wind. Since the launch was conducted in daylight, the ascent rate started out at 1000 fpm and remained high until reaching ceiling.

Flight track was unusual in that it extended east over the bay for about thirty miles. At 60,000 feet, the balloon began to drift west, reaching ceiling just north of Churchill. Winds aloft averaged 35 to 45 knots.

The balloon reached the recovery area north of Uranium City late in the evening. Scientists wanted to let the flight continue until the timers terminated the flight around 0300 in the morning, which would have put the impact beyond Great Bear Lake. Recovery beyond the Slave River becomes a major operation, therefore, the recovery director selected to terminate the flight within the boundaries of the designated recovery area.

The gondola landed 40 minutes later fifty miles north-northeast of Uranium City in a lake. Recovery was performed by helicopter with the gondola being taken back to Uranium City where it was loaded aboard the C-47 and returned to Churchill on Saturday, 15 July, some 33-1/2 hours after launch.

The gondola suffered only slight impact damage. The Raven TRAC package incurred water damage.

This flight ended the University of New Hampshire's Churchill series. The University of New Hampshire's crew packed equipment for one more flight to be flown from Cape Girardeau, Missouri, in September 1972 and departed Churchill on 17 July.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1327 Director Fulkerson
2. Scientist Webber Group U of N. Hampshire Date/Time 7-14-72 / 1331 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 10@ 50@ 80@ 250@ 42°F 330° 3 MPH SLP-1003.2 Cross Wind Angle 20°
   (Sky-Temp-Wind-Pressure)

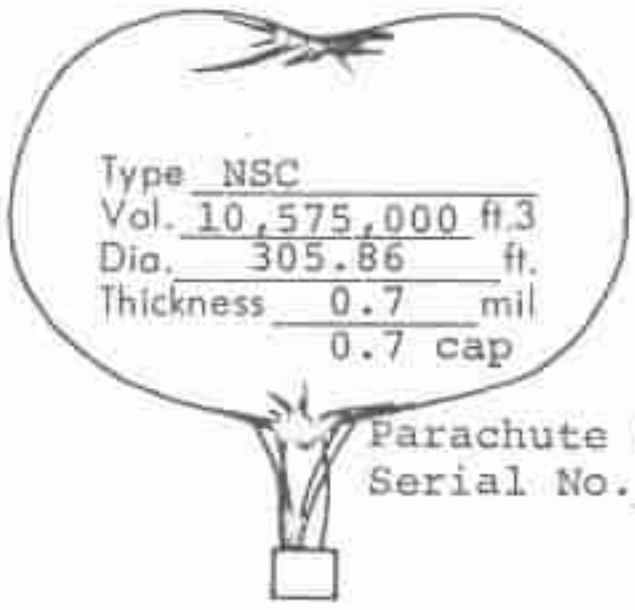
   Trop (Coldest) Ht. 31,000 ft. Temp -53.0 °C Inflation Start 1300 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 500 ft.
5. Balloon: Theoretical 3.59 - 2.94 Mbs. 129.9 - 135.0 K ft. How Determined? MFG Curve

   Ceiling: Actual 3.2 Mbs. 133.0 K ft Transducer
6. Ascent: Surfact to Trop. 970 fpm Trop. to Ceiling 700 fpm
7. Flight Duration: Total 15 hrs. 23 min. At Ceiling 12 hrs. 25 min.
8. Termination: Time 0415 Z Altitude 134.5 K ft. Cause R/C - C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-15-72 0454 Z Location 107° 22' W 60° 25' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
250.7	Telemetry	16.0
149.4	Communications & Command	16.0
7465	Communications	16.0

12. Balloon: Code Number SF 305.86-070-NSC-20 Serial Number 411



Timer&

Parachute Size 49'
Serial No. 9-4046-4

WEIGHTS

Balloon	1,273
Parachute&Rigging	53
Instrumentation Rayen	58
Ballast	350
Scientific Package	682
Other Crush Pad	35
Other Anderson	25
Gross Weight	2,476
Free Lift .14%	347
Gross Inflation	2,823
Helium used (cu. ft.)	43,756

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Hugh Anderson Hitch Hike
    (Significant factors concerning the operation)

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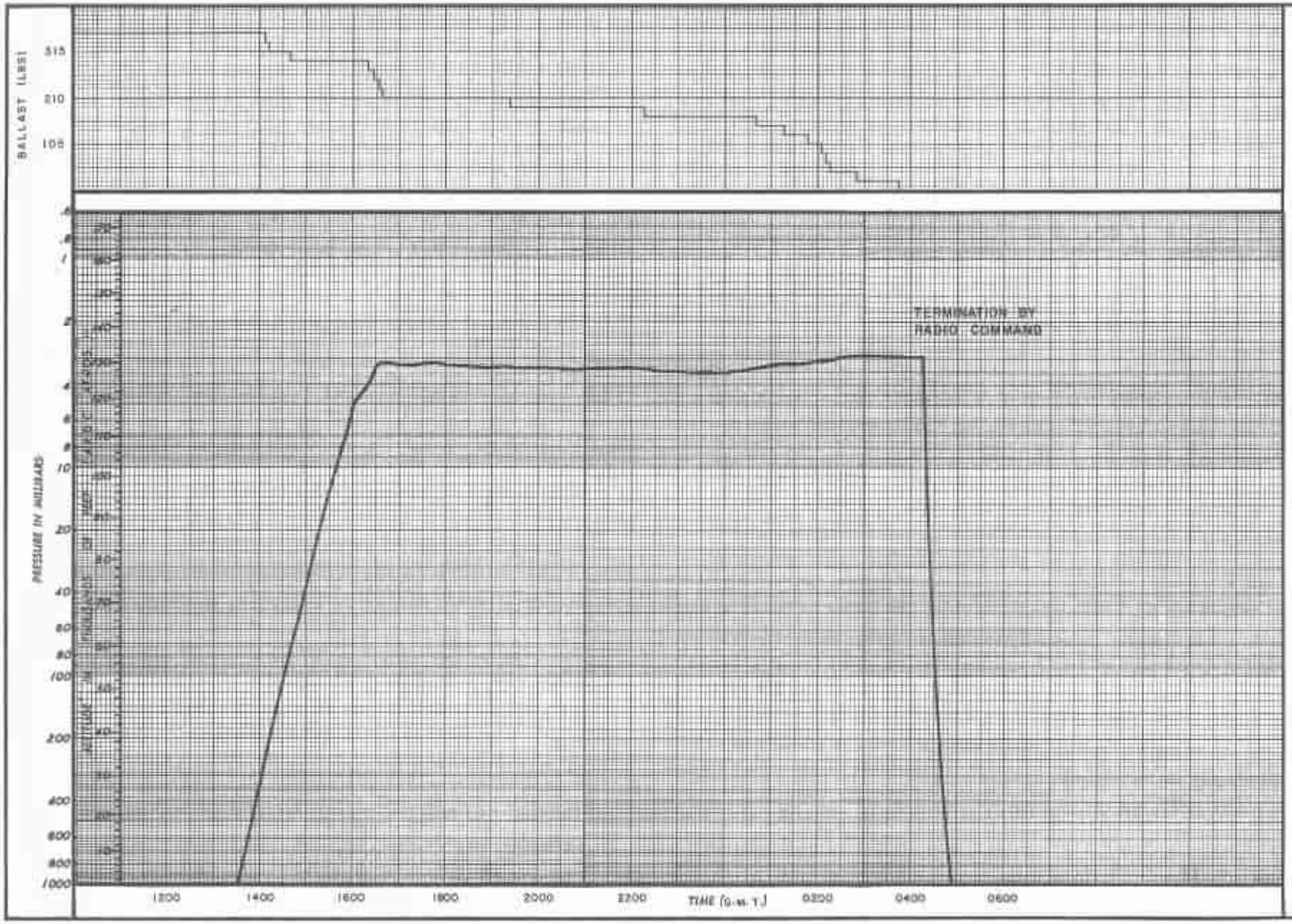
ONR/Fld Rep/Minn
ONR/Code 421



FLIGHT NO. 1327

DATE: 14 JULY 72

FORU OF N.HAMPSHIRE

BALLOON

TYPE: NSC

VOL: 10,575,000 FT^3

MATL: 0.7 MIL POLY
0.7 MIL CAP

WT: 1273 LBS

LOAD FACTORS

PAYLOAD: 1203

GROSS LD: 2476

FREE LIFT: 347

BALLAST: 350

RAVEN industries, inc.

DR:

CHK:

APPR:

R-0473002

1323 - FLIGHT DESCRIPTION

UNIVERSITY OF CHICAGO
21 July 1972
Dr. P. Meyer - G. Fulks

Personnel from the University of Chicago arrived in Churchill on 24 June, with two separate experiment instruments.

The two experiments have been flown from Churchill numerous times over the past five years. A counter experiment, it is designed to measure the spectrum of primary electrons and study its time dependence. Data is telemetered through a separate data link, monitored by the University of Chicago. In addition, data is also recorded on an on-board tape recorder, which records data beyond the normal telemetry range.

The general configuration of the experiment is a low cylinder approximately 28 inches tall and 30 inches in diameter mounted on a truss of light aluminum angle, which provides attachment for the balloon control instruments, ballast hoppers, external battery supplies, and dual photobarographs. A honeycomb crush pad is attached to the bottom of the truss.

Three flights were scheduled for the 1972 program, all using a 15 MCF balloon, of 0.5 mil construction with two 0.5 mil caps. This balloon has had a good record over the past three years and is slowly replacing the 10.6 which was a Skyhook Churchill mainstay.

On July 9, the experiment was prepared for launching. Launch requirements called for a release of the balloon between 9:30 and 11:30 CDT. Weather conditions were favorable, however, low clouds with light rain showers made wind velocities and directions variable. The balloon was laid out and all systems checked completely and ready for inflation. Inflation was delayed due to an 80° wind shift. During the delay, the experiment package developed a problem in its telemetry link which later proved to be a faulty plug. Since time was running out, it was decided to repack the balloon and schedule the flight for the following evening. The gondola was left suspended on the launch truck and parked inside the operations hangar where the batteries could be recharged.

Flight 1323 was rescheduled again on 19 July, when surface winds seemed favorable. The balloon was laid out in the center of Runway 7-25. A delay occurred when the Raven telemetry indicated an R.F. interference problem, which was later solved by relocating the Raven receiving antenna.

Prior to beginning inflation, the surface wind shifted to 340° and increased to nine knots with a temperature drop of 35° in 40 minutes. The winds above 150 feet were 160° and at 300 feet, winds were at 250°.

Flight 1323 was cancalled and rescheduled for the next evening. The balloon was packed back into the box for the second time. The scientific experiment was left suspended on the launch truck which was parked inside the hangar.

During this delay, a hitchhike experiment was placed on the flight frame. On 21 July, weather conditions were most favorable since upper winds indicated ascent trajectory would be easterly and over the bay. The balloon selected for this flight had been laid out twice and put back in the box. Although it sustained no known damage, it was exchanged for another which had never been out

of its box. Any balloon problem over the bay would most likely end up with the loss of the experiment.

Well within the early part of the "Launch Window" the gondola was gently released from the launch truck.

When reaching its theoretical altitude, the balloon was just south of Fort Churchill. Flight 1323 traveled along at 45 MPH, passing Flight 1330 which had been released some three hours sooner.

After floating at ceiling for fifteen hours, the flight was terminated by the Cessna 206 tracking aircraft. The gondola landed 38 minutes later in what turned out to be a hard landing. Thirty hours later the gondola was back in Churchill.

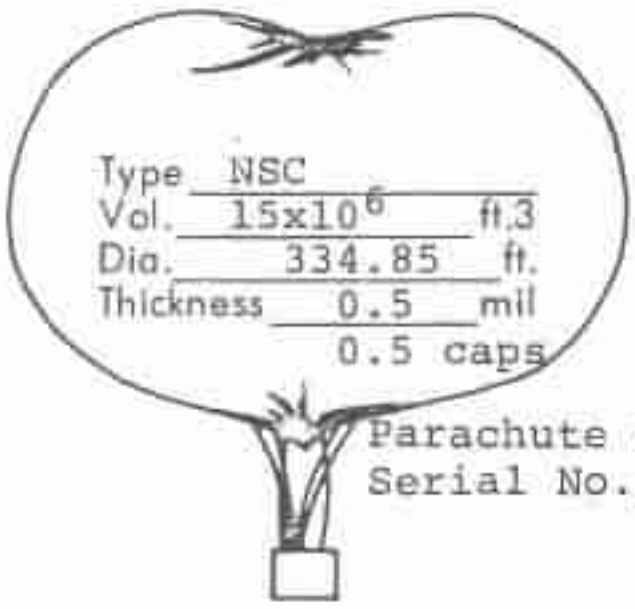
A second gondola was on standby in the event the damaged gondola couldn't be repaired.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1323 Director Reid
2. Scientist Meyer - Fulks Group U of Chicago Date/Time 7-22-72/ 0000 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 50⊕ 68°F 280° 8 MPH SLP-1018.2 Cross Wind Angle 10°
   (Sky-Temp-Wind-Pressure)
   Trop (Coldest) Ht. 35,000 ft. Temp -53.0 °C Inflation Start 21/2330 Z
   Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.
5. Balloon: Theoretical 2.36 - 1.97 Mbs. 140.8 - 145.6 K ft. How Determined? MFG Curve
   Ceiling: Actual 2.2 Mbs. 142.6 K ft Transducer
6. Ascent: Surfact to Trop. 777 fpm Trop. to Ceiling 607 fpm
7. Flight Duration: Total 19 hrs. 36 min. At Ceiling 15 hrs. 18 min.
8. Termination: Time 1858 Z Altitude 146.0 K ft. Cause R/C - 206
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-22-72/ 1936 Z Location 112° 38' W 56° 56' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
248.6	Telemetry	21.0
149.4	Communications & Command	21.0
7465	Communications	21.0

12. Balloon: Code Number SF 334.85-050-NSC-03 Serial Number 29



WEIGHTS

Balloon	1,256
Parachute & Rigging	57
Instrumentation Raven	58
Ballast	350
Scientific Package	532
Other Crush Pad	22
Other	
Gross Weight	2,275
Free Lift 14%	319
Gross Inflation	2,594
Helium used (cu. ft.)	40,207

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Biostack Hitch Hike
    (Significant factors concerning the operation)

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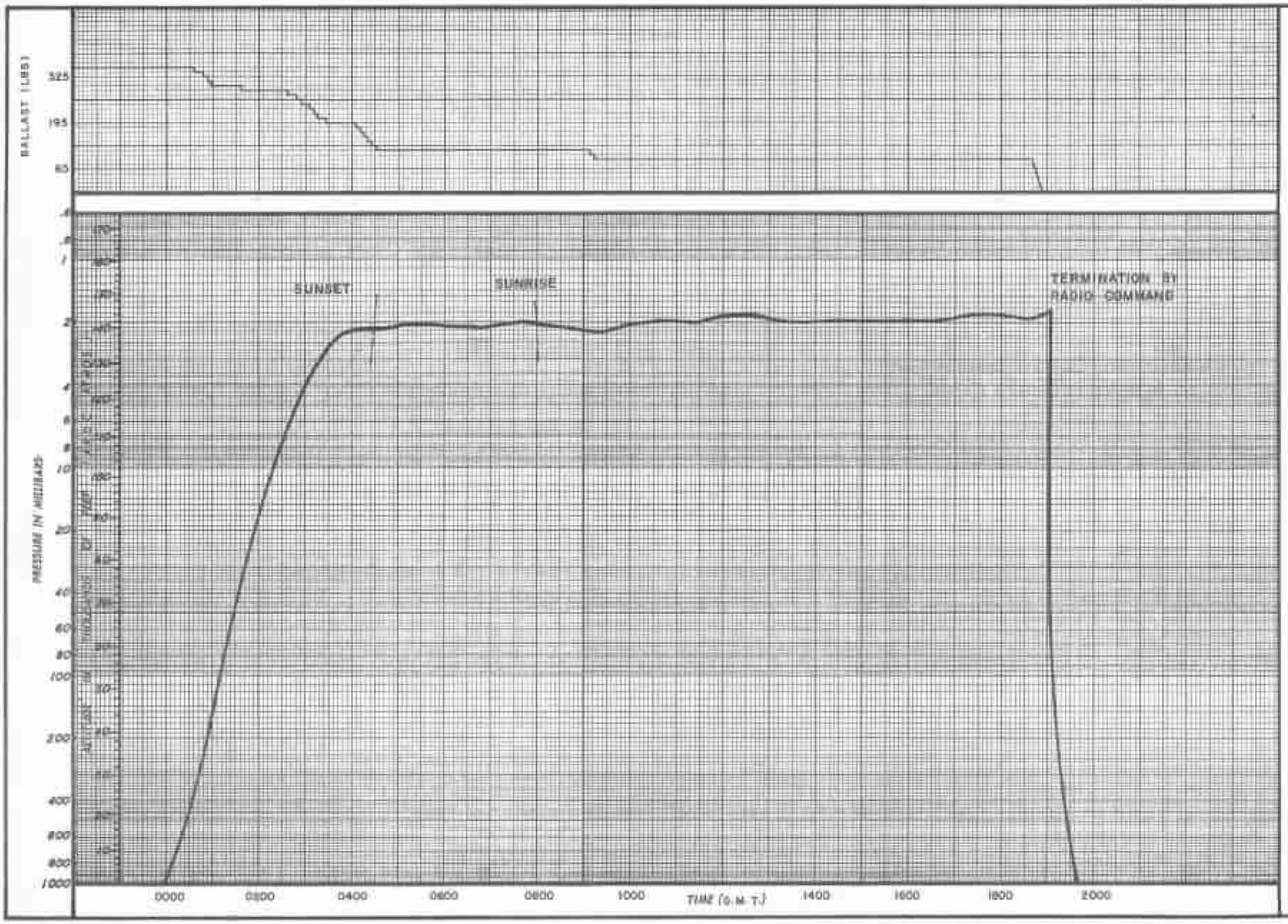
ONR/Fld Rep/Minn
ONR/Code 421



FLIGHT NO. 1323

DATE: 22 JULY 72

FOR: U OF CHICAGO

BALLOON

TYPE: NSC

VOL: 15×10^6 FT^3

MATL: 0.5 MIL POLY
(2) 0.5 MIL CAPS

WT: 1256 LBS

LOAD FACTORS

PAYLOAD: 1019

GROSS LB: 2275

FREE LIFT: 319

BALLAST: 350

RAVEN
industries, inc.

DR.

CHK.

APPR.

SLAVE RIVER

FORT SMITH

FT. CHIPEWYAN

URANIUM CITY

LAKE ATHABASKA

0543 (CUTDOWN)

0500

0400

0300

0625
(IMPACT)

PEACE RIVER

114°

CLAIRE LAKE

EMBARRAS

108°

ATHABASKA RIVER

CREE LAKE

1857
(CUTDOWN)

1800

1700

1600 FLT 1323

1500

1400

FLT 1333

1936
(IMPACT)

MC MURRAY

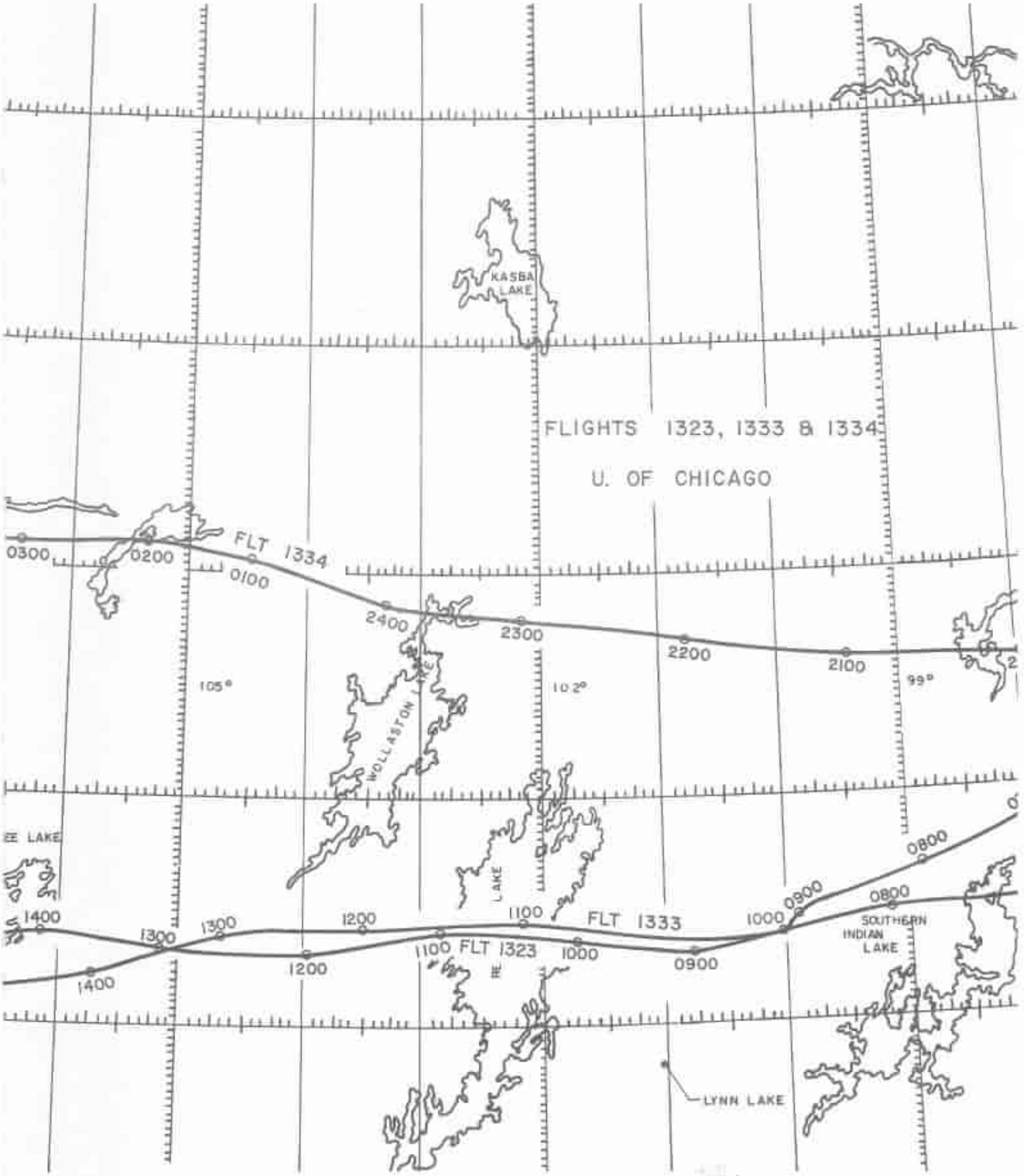
1800 (CUTDOWN)

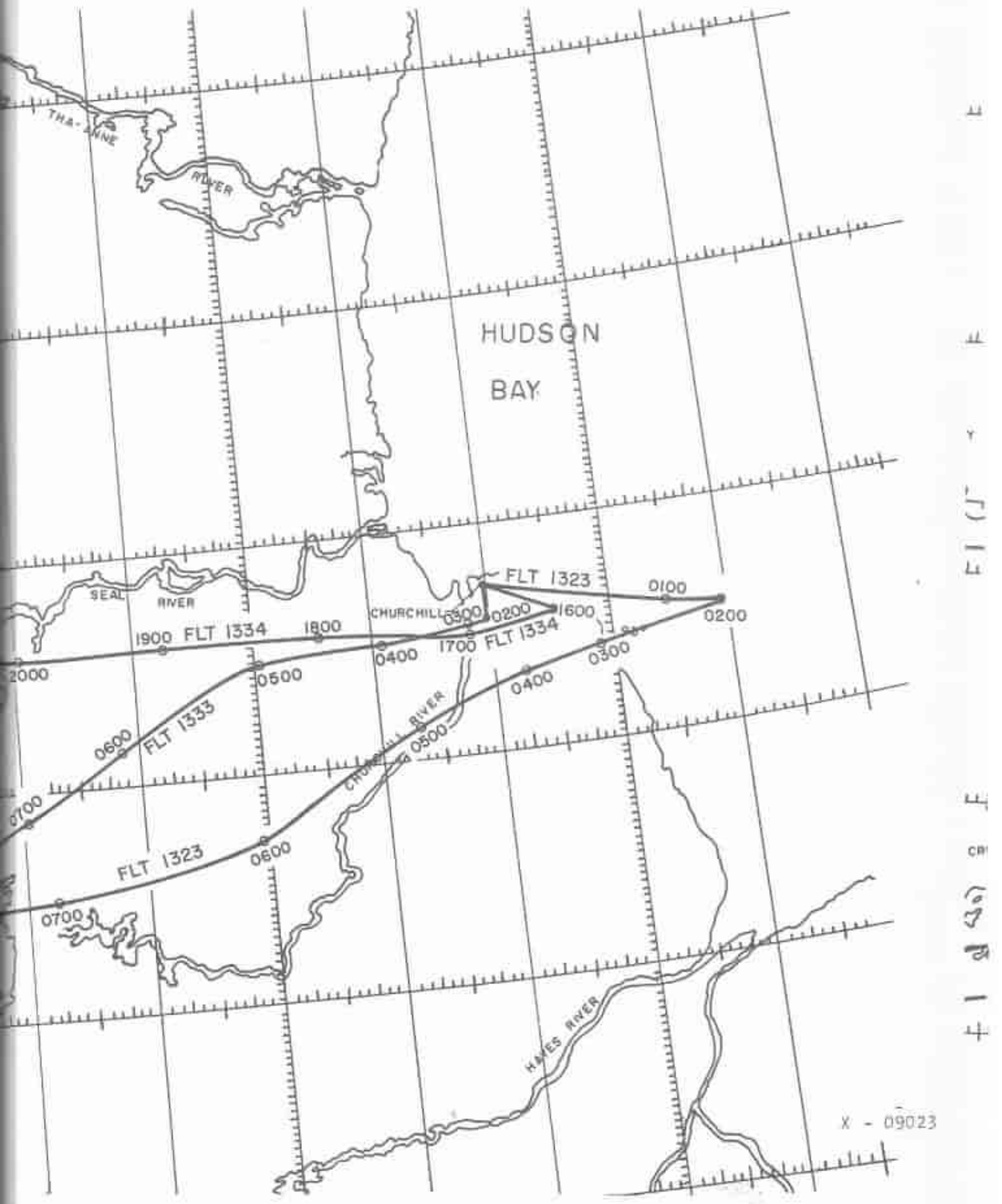
1700

1600

1500

1851
(IMPACT)


KASBA LAKE
FLIGHTS 1323, 1333 & 1334
U. OF CHICAGO
FLT 1334
0300
0200
0100
2400
2300
2200
2100
105°
102°
99°
WOLLASTON LAKE
LAKE
0800
0900
1000
1100
1200
1300
1400
FLT 1333
FLT 1323
SOUTHERN INDIAN LAKE
LYNN LAKE


THA-ANNE
RIVER
HUDSON
BAY
SEAL
RIVER
CHURCHILL
FLT 1323
0100
0200
1600
0300
1900 FLT 1334
1800
0400
1700 FLT 1334
2000
0500
0600
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0700
FLT 1323
0600
0500
0400
0300
0200
0100
CHURCHILL RIVER
HAYES RIVER
X - 09023

1333 - FLIGHT DESCRIPTION

UNIVERSITY OF CHICAGO
26 July 1972
Dr. P. Meyer - G. Fulks

The experiment on Flight 1333 was the same as flown on Flight 1323. Some refitting of the support frame was necessary due to damage from the previous flight.

The Biostack Hitchhike experiment for Professor Herbert, University of Ottawa, Ontario, was attached for a second time.

A smooth launch was executed under near calm conditions. The overall ascent rate, from launch to a ceiling of 2.0 MBS (146,000 feet), averaged 655 feet per minute. A total of 215 pounds ballast was expended during ascent.

The experiment performed perfectly during its thirteen hours at ceiling. The last two hours of flight indicated wind velocities to be in 50 to 60 MPH range, which shortened the flight duration slightly.

Termination of the balloon flight was by command from the C-47 tracking aircraft. The flight system total weight of 669 pounds descended to a general landing in 51 minutes.

Raven control instrumentation performed well, except for a short period of time in which ballast could not be commanded.

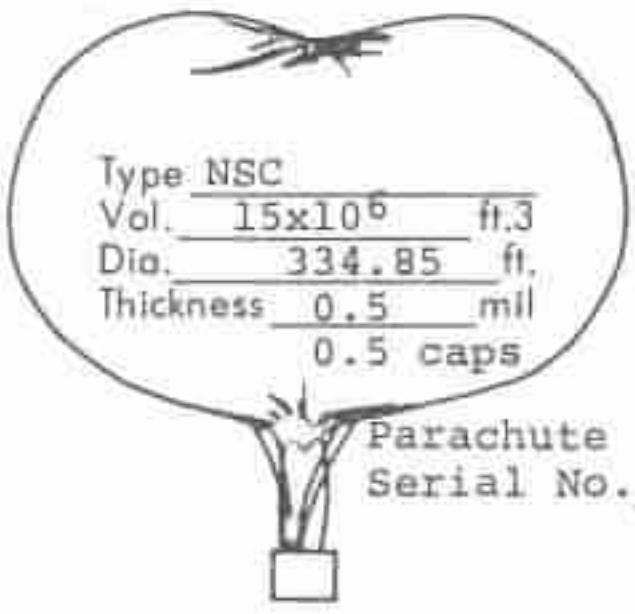
The gondola was recovered by helicopter and flown 20 miles to Fort McMurray for the return trip to Churchill aboard the C-47.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1333 Director Reid
2. Scientist Meyer - Fulks Group U of Chicago Date/Time 7-26-72/ 0057 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 15Φ 250-Φ 46°F 120° 2 MPH SLP-1020.1 Cross Wind Angle 10°
   (Sky-Temp-Wind-Pressure)
   Trop (Coldest) Ht. 36,000 ft. Temp -59.0 °C Inflation Start 0025 Z
   Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.
5. Balloon: Theoretical 2.35 - 2.0 Mbs. 140.8 - 145.6 K ft. How Determined? MFG Curve
   Ceiling: Actual 2.0 Mbs. 146.0 K ft Transducer
6. Ascent: Surfact to Trop. 900 fpm Trop. to Ceiling 598 fpm
7. Flight Duration: Total 17 hrs. 54 min. At Ceiling 13 hrs. 29 min.
8. Termination: Time 1800 Z Altitude 148.0 K ft. Cause R/C C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-26-72/ 1851 Z Location 111° 51' W 56° 34' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
248.6	Telemetry	19.0
149.4	Communications & Command	19.0
7465	Communications	19.0

12. Balloon: Code Number SF 334.85-050-NSC-03 Serial Number 28



WEIGHTS

Balloon	1,296
Parachute & Rigging	57
Timer & Instrumentation Raven	58
Ballast	350
Scientific Package	532
Other Crush Pad	22
Other	
Gross Weight	2,315
Free Lift . 14%	324
Gross Inflation	2,639
Helium used (cu. ft.)	40,904

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Biostack Hitch Hike
    (Significant factors concerning the operation)

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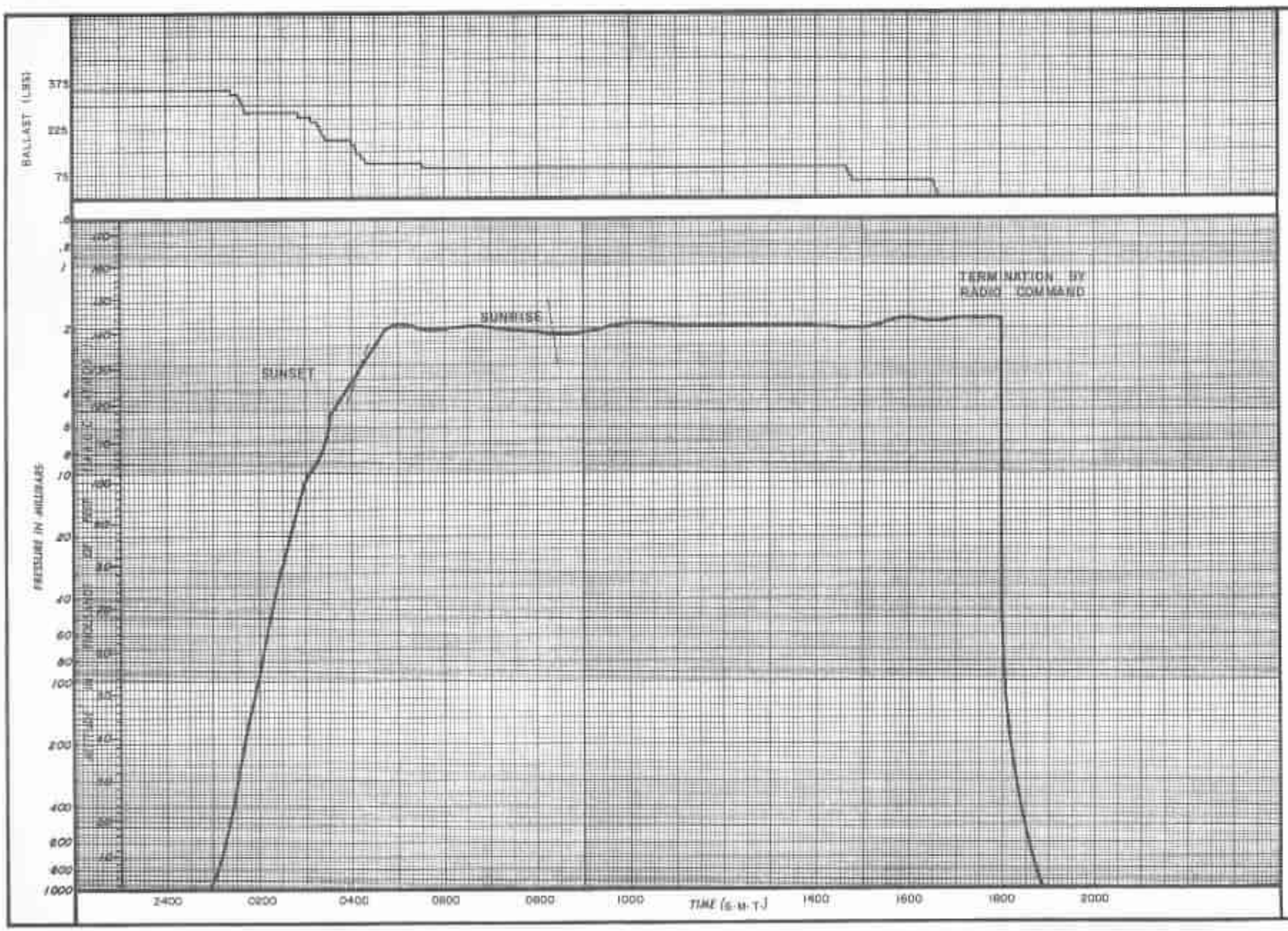
ONR/Fld Rep/Minn
ONR/Code 421



FLIGHT NO. 1333

DATE: 26 JULY 72

FOR: U OF CHICAGO

BALLOON

TYPE: NSC

VOL: 15 x 10^6 FT^3

MAT'L: 0.5 MIL POLY
(2) 0.5 MIL CAPS

WT: 1296 LBS

LOAD FACTORS

PAYLOAD: 1019

GROSS LD: 2315

FREE LIFT: 324

BALLAST: 350

RAVEN
industries, inc.

DR.

CHK.

APPR.

1334 - FLIGHT DESCRIPTION

UNIVERSITY OF CHICAGO
27 July 1972
Dr. P. Meyer - G. Fulks

The flight included the second gondola. The experiment had been assembled since its arrival in Churchill but was apparently not available for flight. However, on 27 July, after word was received that the program was to be ended on 30 July, the gondola was made ready for flight.

The launch was very smooth, with the balloon rising directly over the launch truck. The truck was moved into proper position after 16 seconds. The wind was 12 knots at the time of launch.

The ascent was normal for the first 80,000 feet, however, at the point of transistion from Raven's low to high altitude transducer, the Rosemount transducer failed. Data was obtained from the University of Chicago telemetry link.

The trajectory was such that early afternoon found the balloon over an area unsuitable for recovery. It was decided to allow the flight to continue after sundown until it reached a more suitable area for recovery. The tracking aircraft turned over the flight to the Uranium City Center, which tracked the flight to the south of Uranium City where it was terminated.

Tracking aircraft left the following morning and located the gondola using ranging data.

This concluded the 1972 Churchill series for the University of Chicago.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1334 Director Reid
2. Scientist Meyer - Fulks Group U of Chicago Date/Time 7-27-72/ 1447 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 250 -@ 59°F 180° 14 MPH SLP-1018.6 Cross Wind Angle 0°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 35,000 ft. Temp -59.0 °C Inflation Start 1425 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.

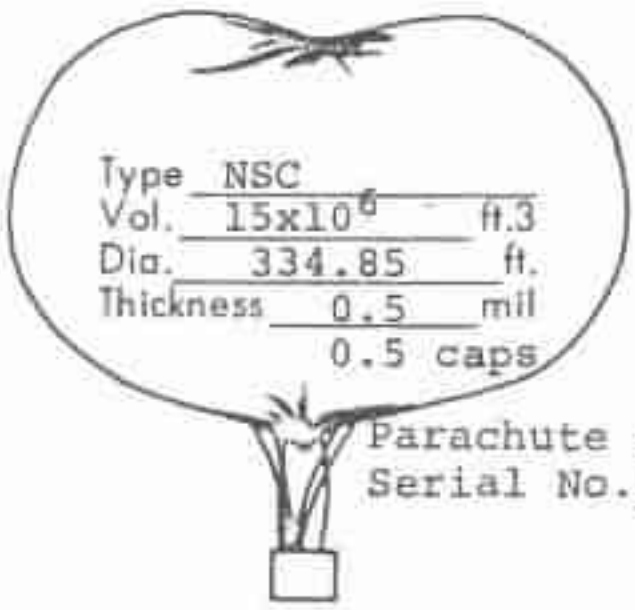
5. Balloon: Theoretical 2.35 - 1.95 Mbs. 141.2 - 146.0 K ft. How Determined? MFG Curve

Ceiling: Actual --- Mbs. --- ft Transducer Failure

6. Ascent: Surfact to Trop. 970 fpm Trop. to Ceiling --- fpm
7. Flight Duration: Total 15 hrs. 38 min. At Ceiling 12 hrs. 25 min.
8. Termination: Time 0543 Z Altitude --- ft. Cause R/C - UC
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-28-72/ 0625 Z Location 109° 07' W 58° 46' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time,
248.6	Telemetry	16.0
149.4	Communications & Command	16.0
7465	Communications	16.0

12. Balloon: Code Number SF 334.85-050-NSC-03 Serial Number 27



Timers&

WEIGHTS

Balloon	1,248
Parachute & Rigging	53
Instrumentation Raven	58
Ballast	350
Scientific Package	543
Other Crush Pad	22
Other	
Gross Weight	2,274
Free Lift	318
Gross Inflation	2,592
Helium used (cu. ft.)	40,176

13. Flight Failures Transducer failure.
(Nature of flight failures - if any)

14. Comments Nighttime termination--no aircraft in area.
(Significant factors concerning the operation)

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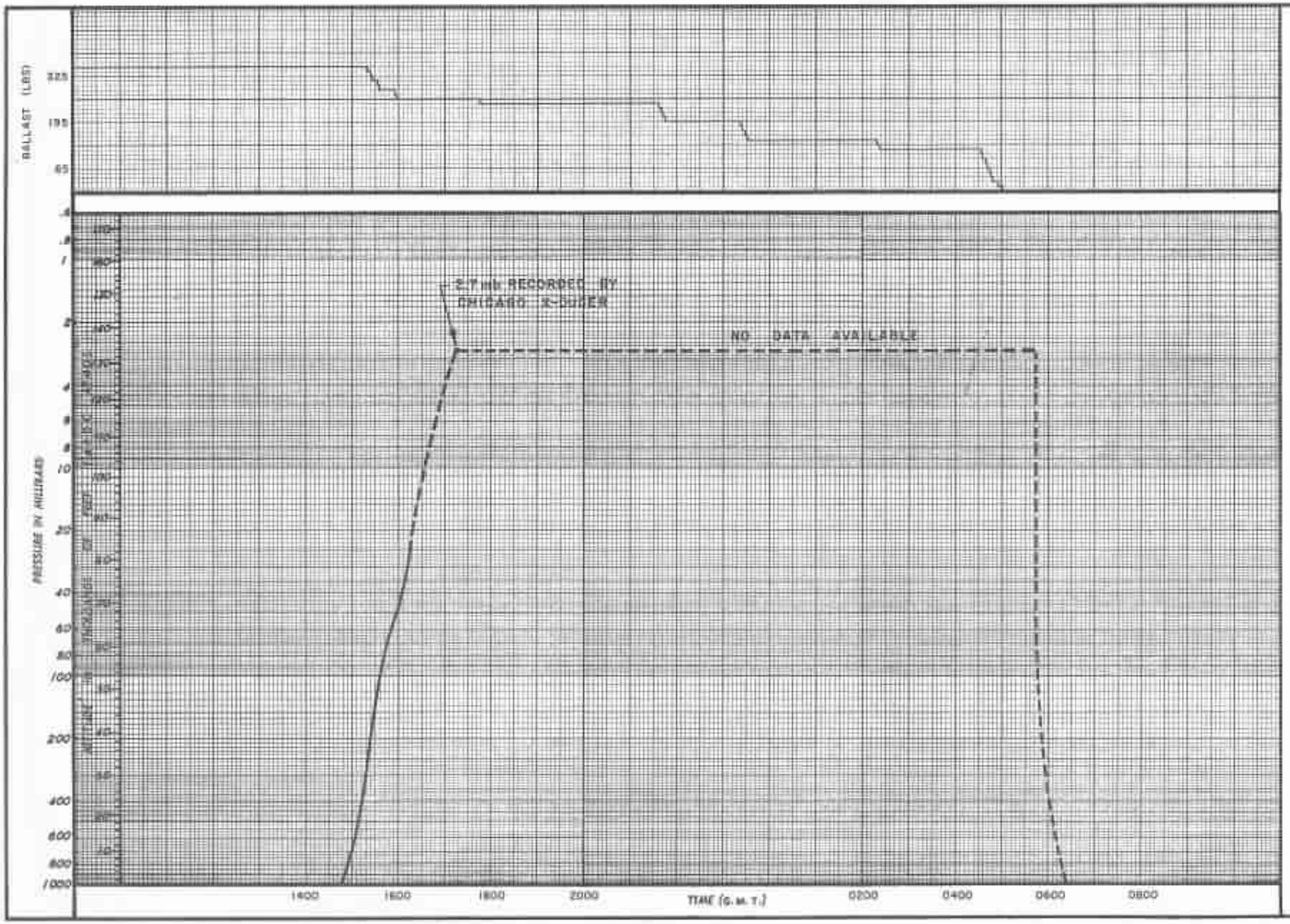
ONR/Code 421



FLIGHT NO. 1334

DATE: 27 JULY 72

FOR: U OF CHICAGO

BALLOON

TYPE: NSC

VOL: 15×10^6 FT^3

MATL: 0.5 MIL POLY (2) 0.5 MIL CAPS

WT: 1248 LBS

LOAD FACTORS

PAYLOAD: 1026

GROSS LD: 2274

FREE LIFT: 318

BALLAST: 350

RAVEN industries, inc.

DR.

CHK.

APPR.

1330 - FLIGHT DESCRIPTION

UNIVERSITY OF MARYLAND
21 July 1972
Dr. J. Earl, J. Luhmann, L. Bagg

Scientists of the University of Maryland brought three separate experiments to Churchill. Three flights were scheduled, two flights on 11.6 MCF balloons and one on a 2.94 MCF.

The largest experiment would be flown twice, each time being accompanied by one of the two small experiments. The last flight would carry both small experiments.

"Perse" and "Old Stack" are veteran hodoscopes of the Churchill Skyhook Program. "Perse", the largest, has been flown three times from Churchill, while "Old Stack" has accumulated about 25 flights from Churchill. "Athena", also a hodoscope, was new to the program, having been built in 1972.

Experiment Description

1. Perse'

Largest of the three University of Maryland experiments is affectionately called, "The Mother Hodoscope" by its technicians. This experiment consists of a geiger tube directional filter with a geometrical factor of 200 cm^2, two five-inch plastic scintillator calorimeters, and a lucite Cerenkov counter.

Special features include a scarlet fiberglass inflatable dome for clamping together the trays of geiger tubes, a black vinyl clad "wet look" plastic de/dx counter. All detectors feed logarithmic pulse-height analyzers with a dynamic range of 2000. Partical species and energy are determined from their location in a four dimensional matrix of de/dx - Cal 1 - Cal 2 - Cerenkov. The data recovery rate is 30 events per second at altitude. Three ADC words are provided for pressure and orthogonal magnetometers.

Perse' had its maiden flight in 1971, and 1972 found it in the perfection of matured beauty.

2. "Old Stack"

"Old Stack" is a small geiger tube hodoscope designed to measure the directionality and flux of primary cosmic ray protons, alpha particles, and electrons. The experiment is contained in a battered aluminum cylinder 18 inches in height and 13-1/2 inches in diameter, and weighs about 100 pounds including its power supply of lead acid aircraft batteries.

3. "Athena"

"Athena", a geiger tube hodoscope for the study of low energy cosmic ray nucleons, employs five trays of geiger tubes and four scintillation detectors, the fourth of which detects penetrating particles only. High light collection efficiency from the first three scintillators and a 512 channel pulse-height analyzer result in high resolution for particle identification. The purpose of Athena is to measure the spectra of cosmic ray nuclei from hydrogen through at least carbon. The good resolution makes it possible to resolve He^3 and He^4. Energy range for protons and helium ranges from 90 MeV/Nucleon to over 250 MeV/Nucleon.

For Flight 1330, "Perse" and "Old Stack" were bolted together with the ever present Anderson Ion Chamber being mounted on top of the battery box.

Data from all three experiments was telemetered. The University of Maryland sent data over a separate data link monitored at Churchill and Uranium City while Anderson information went through the Raven telemetry system.

The 11.6 MCF balloon was especially designed for this experiment. The envelope was constructed of 0.7 mil, with a single cap of 0.9 mil thickness.

Last minute rigging was completed just before taking the launch truck to the launch area. A slight delay occurred when Raven instrument technicians noted a slight voltage at the termination plug on the top of the parachute. The voltage was not of sufficient magnitude to be serious, so last minute preparations for launch were made. A second delay occurred when

a spectator's dog walked on the balloon. The balloon fortunately was not damaged. When scientific personnel returned after losing the race with the dog, the balloon was released in a smooth and timely manner.

Moments after launch, a steady ascent rate of 1000 feet per minute was established and maintained to the tropopause, where it was necessary to expend 44 pounds to maintain a rate of 800 fpm. The balloon leveled off at 132,000 feet, (3.3 mbs) directly over Churchill, 3 hours and 14 minutes after launch.

During its nineteen hours aloft, the flight was allowed to drift westerly beyond Mildred Lake where it was terminated by timers. Descent was through a thunder storm.

Professor Earl attaching the insulating cover to Perse', left and Old Stack, right.

The gondola landed 53 minutes later six miles northeast of the Mildred Lake airport. Having incurred no impact damage, the gondola was taken to the Mildred Lake Airport and returned to Churchill the following day 43-1/2 hours after being sent aloft.

Flight 1330 ended the Churchill season for the University of Rice (Anderson) experiment.

All Raven instrumentation worked flawlessly.

The Maryland gondola was pronounced working on arrival and was ready for reflight on the afternoon of 24 July, along with "Athena."

Larry Bagg preparing monitor equipment for pre-launch checkout.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1330 Director Fulkerson
2. Scientist Earl Group U of Maryland Date/Time 7-21-72/ 2159 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic - M-36
4. Wx: Clear 65°F 290° 10 MPH SLP-1019.0 Cross Wind Angle 10°
   (Sky-Temp-Wind-Pressure)

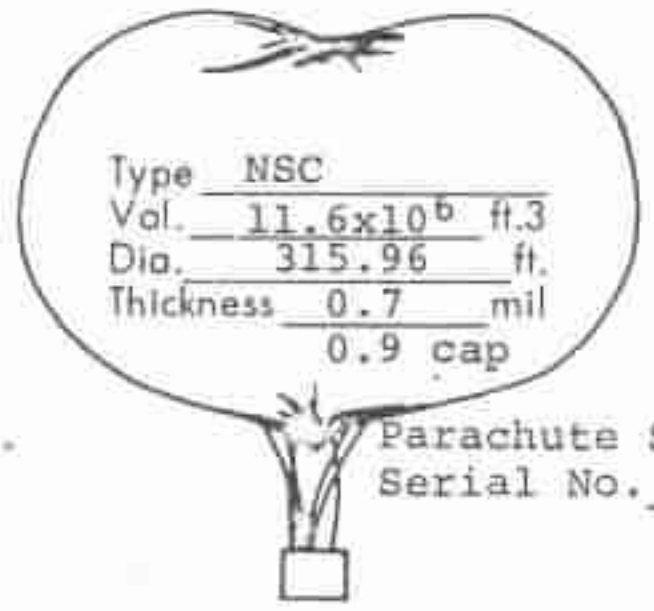
   Trop (Coldest) Ht. 35,000 ft. Temp -53.0 °C Inflation Start 2120 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 500 ft.
5. Balloon: Theoretical 3.54 - 3.11 Mbs. 130.3 - 133.6 K ft. How Determined? MFG Curve

   Ceiling: Actual 3.3 Mbs. 132.0 K ft Transducer
6. Ascent: Surfact to Trop. 946 fpm Trop. to Ceiling 636 fpm
7. Flight Duration: Total 23 hrs. 09 min. At Ceiling 19 hrs. 15 min.
8. Termination: Time 2015 Z Altitude 133.0 K ft. Cause Timer
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-22-72/ 2108 Z Location 111° 22' W 57° 06' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	24.0
149.4	Communications & Command	24.0
7465	Communications	24.0

12. Balloon: Code Number SF 315.96-070-NSC-02 Serial Number 3



WEIGHTS

Balloon	1,488
Parachute &Rigging	92
Timer& Instrumentation Raven	60
Ballast	350
Scientific Package	770
Other Anderson	25
Other Crush Pad	11
Gross Weight	2,796
Free Lift 14%	391
Gross Inflation	3,187
Helium used (cu. ft.)	49,398

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Hugh Anderson Hitch Hike
    (Significant factors concerning the operation)

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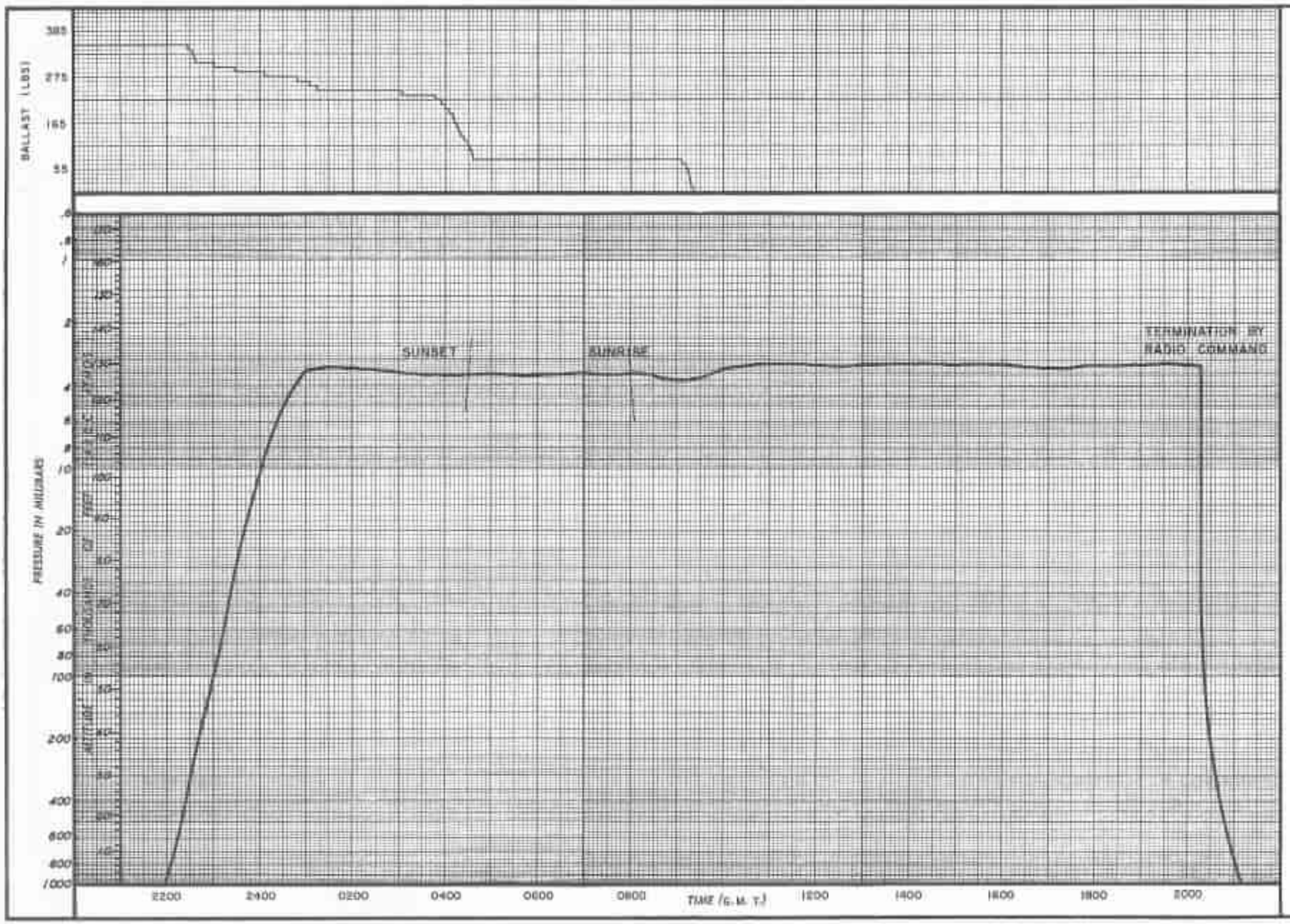
ONR Fld Rep Minn
ONR Code 421



FLIGHT NO. 1330

DATE: 21 JULY 72

FOR: U OF MARYLAND

BALLOON

TYPE: NSC

VOL: 11.6×10^6 FT^3

MATL: 0.7 MIL POLY
0.9 MIL CAP

WT: 1488 LBS

LOAD FACTORS

PAYLOAD: 1308

GROSS LO: 2796

FREE LIFT: 391

BALLAST: 350

RAVEN industries, inc.

DR.

CHK.

APPR.

R-0473002

1332 - FLIGHT DESCRIPTION

UNIVERSITY OF MARYLAND
26 July 1972
Dr. J. Earl, L. Bagg, Dr. O'Gallagher, H. Leach

The second flight of the season for the University of Maryland included the large Hodoscope experiment, "Perse" and the new Hodoscope "Athena", with a Hitchhike from Professor Hasegawa of St. Paul University, Tokyo, Japan.

The balloon was a 11.6 MCF and identical to that used on the first flight.

The launch was accomplished without incident in a surface wind of seven knots.

After 17-1/2 hours at ceiling of 120,000 to 130,000 feet, the balloon flight was terminated by the C-47 aircraft. Efforts by Uranium City to terminate the flight had failed. At the time of termination, the balloon was thirty miles west of the Athabaska River, however, winds carried the descending parachute thirty-five miles east.

The flight landed in 45 minutes with an impact velocity calculated at 17.5 fpm. The gondola sustained no damage, and the smaller experiment was ready in two days for reflight.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1332 Director Fulkerson
2. Scientist Earl Group U of Maryland Date/Time 7-26-72/1322 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 70Φ 25O -Φ 50°F 8 MPH SLP-1018.4 Cross Wind Angle 10°
   (Sky-Temp-Wind-Pressure)

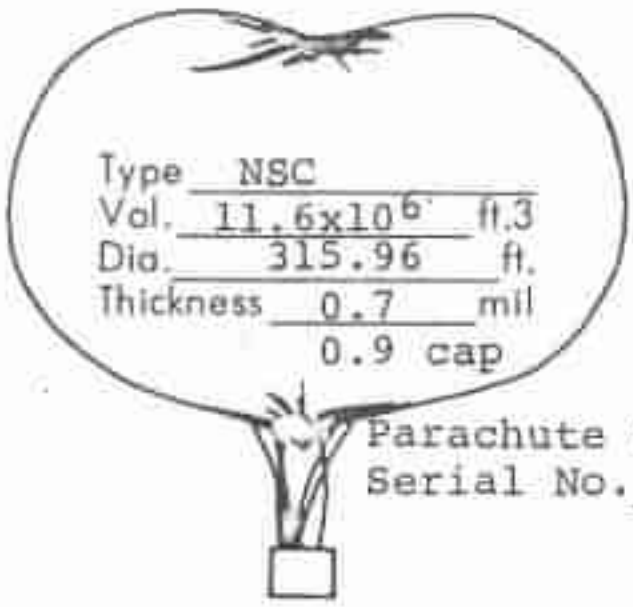
   Trop (Coldest) Ht. 35,000 ft. Temp -54.0 °C Inflation Start 1300 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 500 ft.
5. Balloon: Theoretical 3.56 - 3.16 Mbs. 130.1 - 133.2 K ft. How Determined? MFG Curve

   Ceiling: Actual 3.2 Mbs. 133.0 K ft Transducer
6. Ascent: Surfact to Trop. 1,094 fpm Trop. to Ceiling 851 fpm
7. Flight Duration: Total 20 hrs. 33 min. At Ceiling 17 hrs. 26 min.
8. Termination: Time 0910 Z Altitude 129.0 K ft. Cause R/C - C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-27-72/ 0955 Z Location 111° 08' W 57° 46' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	21.0
149.4	Communications & Command	21.0
7465	Communications	21.0

12. Balloon: Code Number SF 315.96-070-NSC-02 Serial Number 4



WEIGHTS

Balloon	1,519
Parachute &Rigging	92
Timer& Instrumentation Raven	58
Ballast	350
Scientific Package	787
Other Crush Pad	12
Other St. Paul U	20
Gross Weight	2,838
Free Lift . 14%	397
Gross Inflation	3,235
Helium used (cu. ft.)	50,142

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments St. Paul University Hitch Hike
    (Significant factors concerning the operation)

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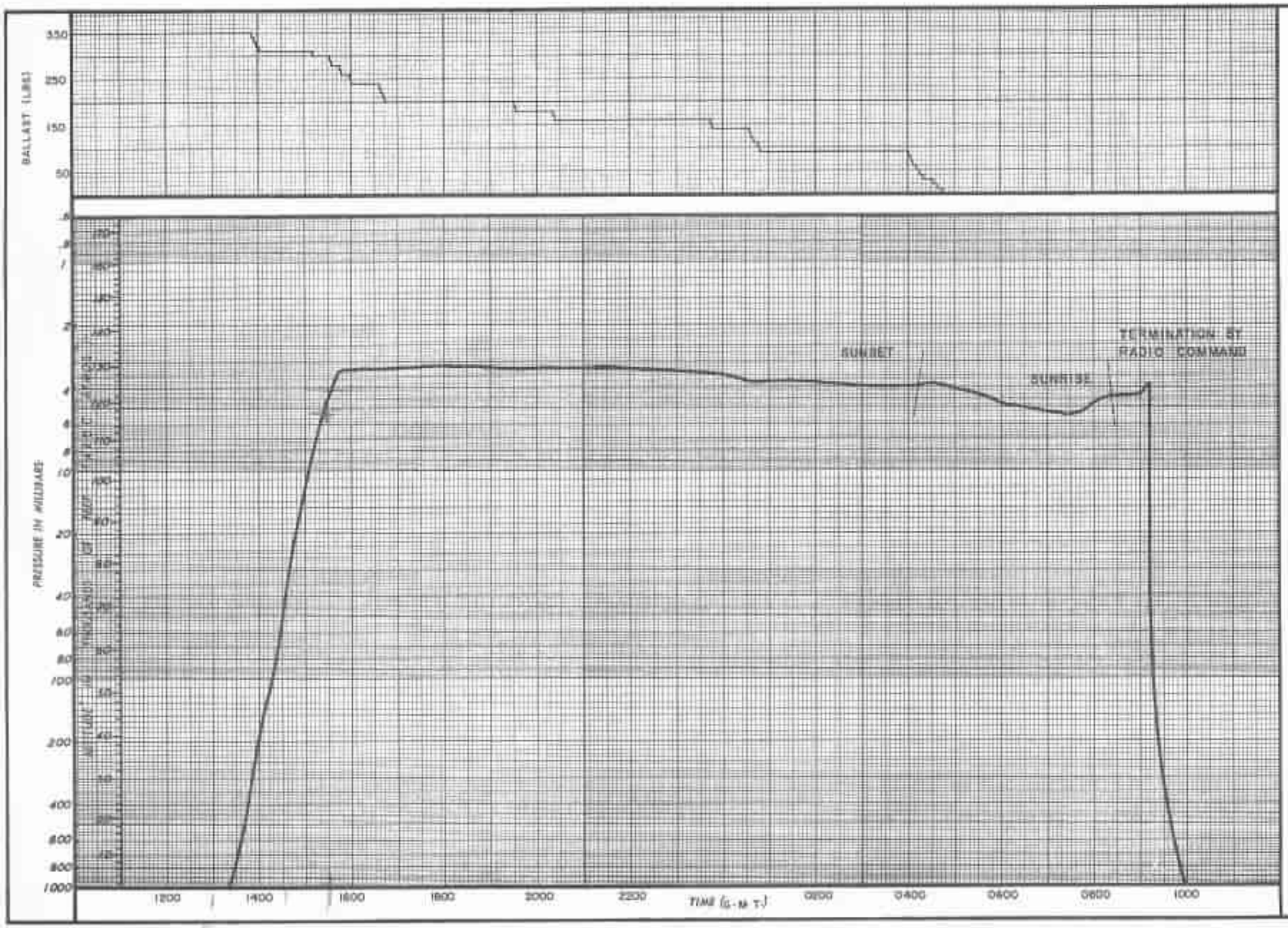


FLIGHT NO. 1332

DATE: 26 JULY 72

FOR: U OF MARYLAND

BALLOON

TYPE: NSC

VOL: 11.6×10^6 FT^3

MATL: 0.7 MIL POLY
0.9 MIL CAP

WT: 1519 LBS

LOAD FACTORS

PAYLOAD: 1319

GROSS LO: 2838

FREE LIFT: 397

BALLAST: 350

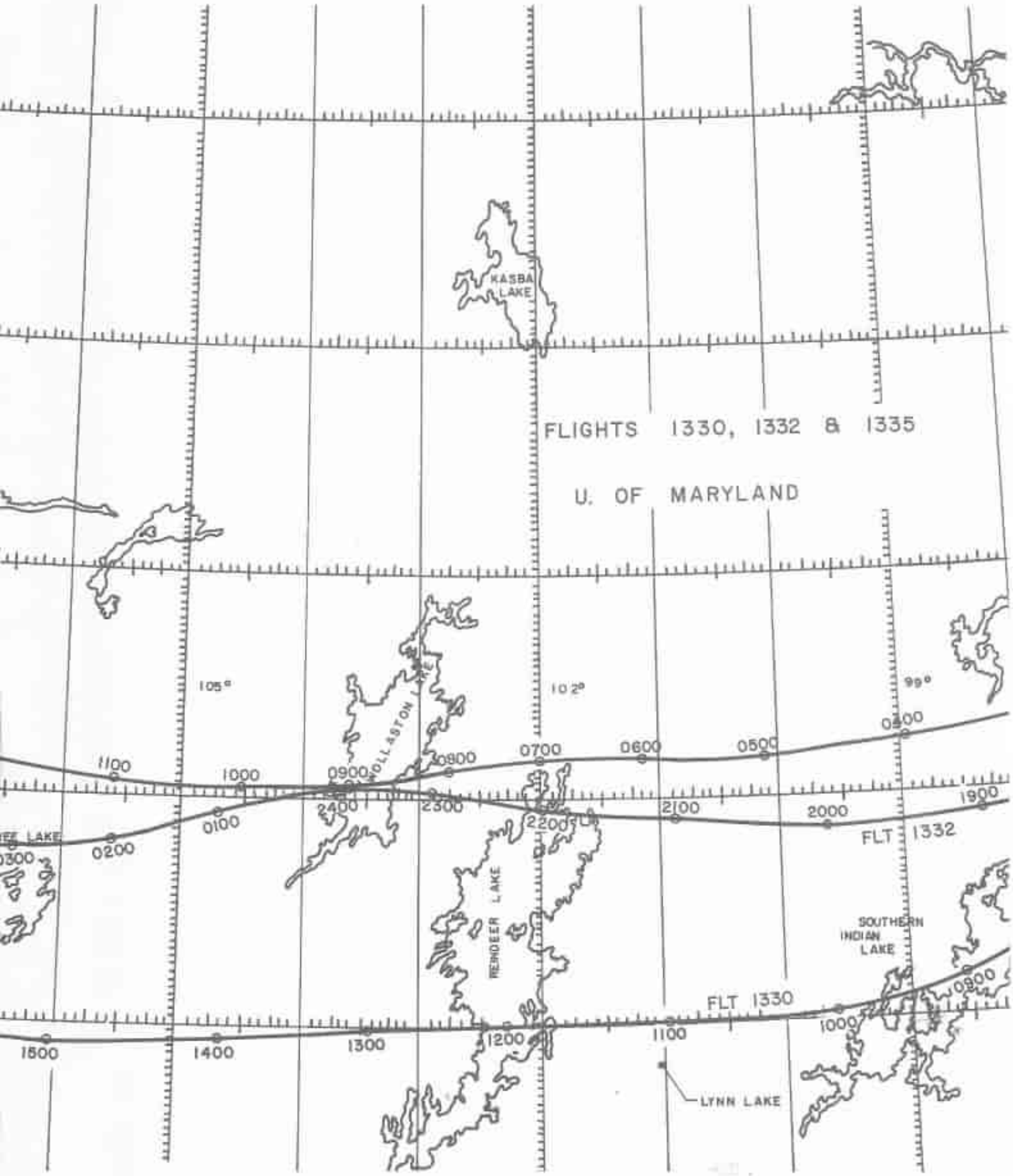
RAVEN industries, inc.

DR.

CHK.

APPR.

SLAVE RIVER
FORT SMITH
FT. CHIPEWYAN
URANIUM CITY
LAKE ATHABASKA
PEACE RIVER
114°
CL AIRE LAKE
1608 (CUTDOWN)
EMBARRAS
1649 (IMPACT)
108°
1500
1400
1300
1200
FLT 1335
0910 (CUTDOWN)
0955 (IMPACT)
ATHABASKA RIVER
0800
0700
0600
0500
0400
FLT 1332
CREE LAKE
0300
2014 (CUTDOWN)
2108 (IMPACT)
MC MURRAY
1900
1800
1700
1600
1500
FLT 1330


KASBA LAKE
FLIGHTS 1330, 1332 & 1335
U. OF MARYLAND
105°
102°
99°
WOLLASTON LAKE
RENDEER LAKE
SOUTHERN INDIAN LAKE
LYNN LAKE
FLT 1332
FLT 1330
0100
0200
0300
0400
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1100
1200
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2000
2100
2200
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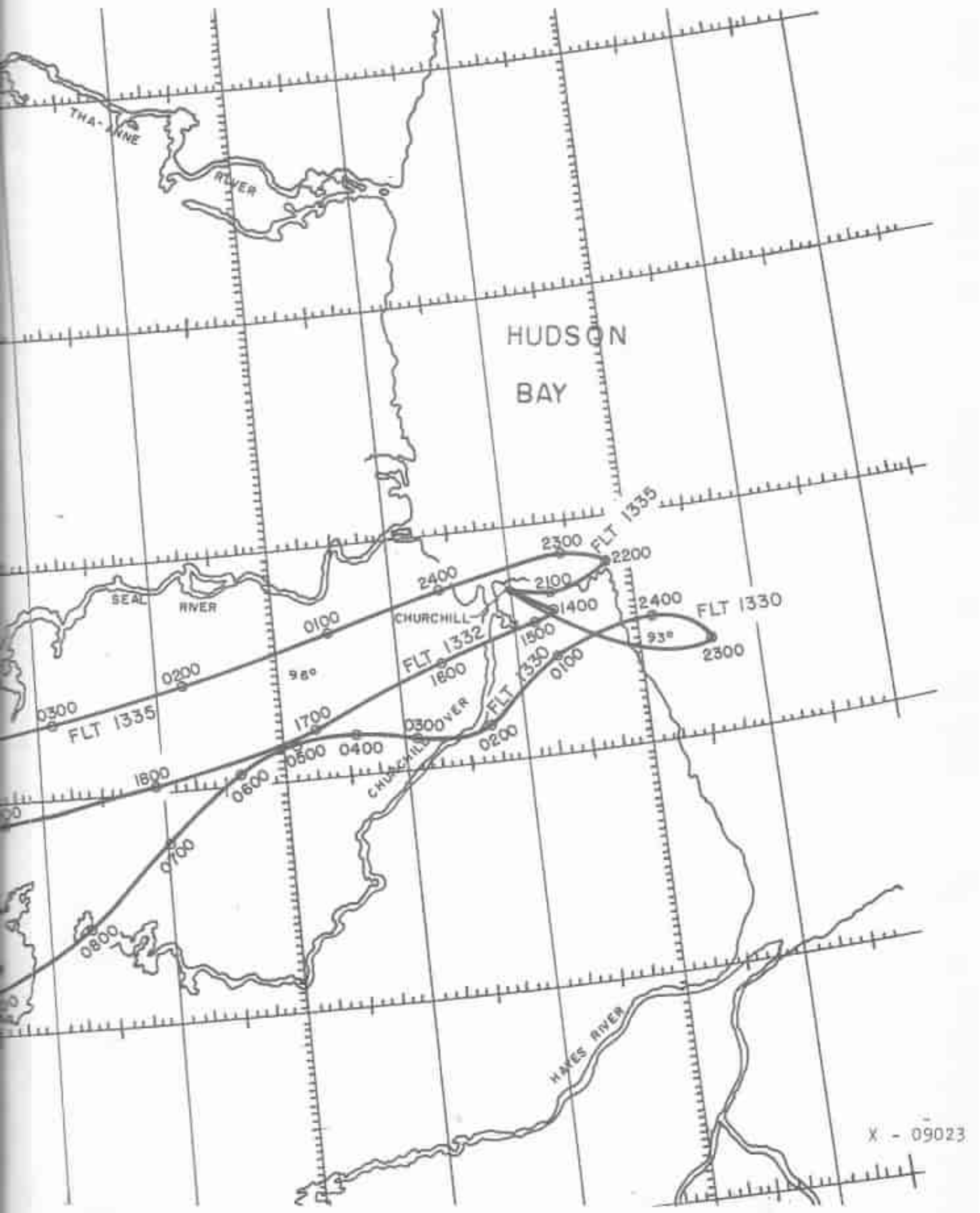

THA-
RIVER
HUDSON
BAY
SEAL
RIVER
CHURCHILL
FLT 1335
2300
2200
2400
2100
1400
FLT 1330
2400
93°
2300
0100
FLT 1332
1500
1800
FLT 1330
0100
98°
0200
0300
FLT 1335
1700
0300
0500
0400
0200
1800
0600
0700
0800
HAYES RIVER
X - 09023

1335 - FLIGHT DESCRIPTION

UNIVERSITY OF MARYLAND & UNIVERSITY OF CALGARY
29 July 1972
Dr. Earl-Lumen-O'Gallagher-Leach, Bland

Originally the two small Hodoscopes were scheduled to be flown together on a 2.94 MCF balloon, however, since the program was near the end, it was decided to add the University of Calgary experiment to the flight gondola and use a 10.6 MCF balloon.

The University of Calgary experiment was a counter telescope consisting of a gas Cerenkov detector, two scintillation detectors, and a lead glass Cerenkov detector for measurement of primary cosmic ray electrons in the energy interval of approximately 50-500 MeV.

The Calgary experiment was repackaged in a styrofoam box to provide some warmth. The final gondola configuration was quite compact.

Launch of the triple experiment was completed on 29 July.

The balloon reached a ceiling of 132,000 feet and remained reasonably stable until sunset, when it began a slow descent. Ballast was dropped. However, the descent was not stopped until after sunrise, at which time the balloon was at 115,000 feet.

The Churchill Center had difficulty ranging on Flight 1335. The Uranium City station did not observe any ranging problem but did find the range off a little when compared with aircraft fixes.

The University of Maryland's experiment transmitted data over their own telemetry link, while the Calgary data was telemetered via a CRR link. Midway through the flight, the range tracking and telemetry were discontinued due to manpower and fiscal shortages.

The flight was terminated by the C-47 and landed near Embarras. The gondola was in very good shape. The vulnerable Calgary experiment was in perfect condition.

Flight 1335 concluded the 1972 Churchill Skyhook Program.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1335 Director Reid
2. Scientist Earl - Bland Group U of Md.&Calgary Date/Time 7-29-72 / 2032 Z
3. Launch: Site Ft. Churchill Technique/Launch Veh. Dynamic M-36
4. Wx: 6 ⊕ 3F 45°F 040° 9 MPH SLP-1001.8 Cross Wind Angle 0°
   (Sky-Temp-Wind-Pressure)

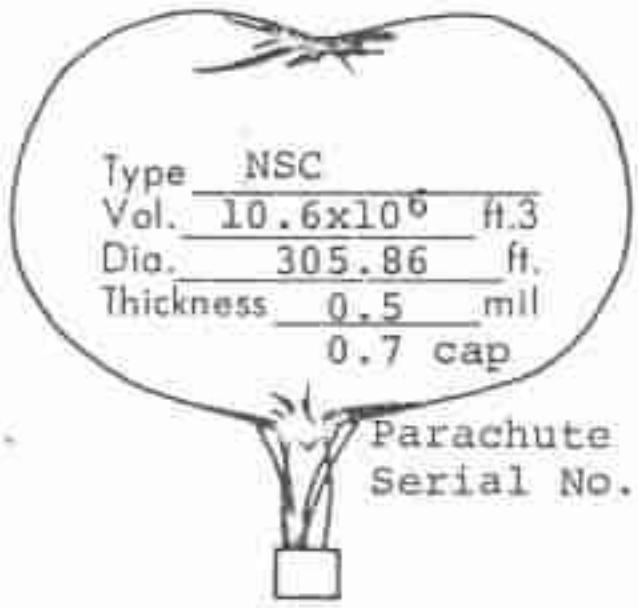
   Trop (Coldest) Ht. 34,000 ft. Temp -56.0 °C Inflation Start 2010 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 500 ft.
5. Balloon: Theoretical 3.0 - 2.65 Mbs. 134.6 - 137.6 K ft. How Determined? MFG Curve

   Ceiling: Actual 2.9 Mbs. 136.0 ft Transducer
6. Ascent: Surfact to Trop. 971 fpm Trop. to Ceiling 654 fpm
7. Flight Duration: Total 20 hrs. 17 min. At Ceiling 16 hrs. 27 min.
8. Termination: Time 1607 Z Altitude 118.0 K ft. Cause R/C C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 7-30-72/ 1649 Z Location 111° 08' W 58° 09' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
250.7	Telemetry	21.0
149.4	Communications & Command	21.0
7465	Communications	21.0

12. Balloon: Code Number SF 305.86-050-NSC-06 Serial Number 159



WEIGHTS

Balloon	1,074
Parachute & Rigging	48
Timer & Instrumentation Raven	58
Ballast	225
Scientific Package	595
Other Crush Pad	10
Other	
Gross Weight	2,010
Free Lift . 16%	321
Gross Inflation	2,331
Helium used (cu. ft.)	36,130

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments
    (Significant factors concerning the operation)

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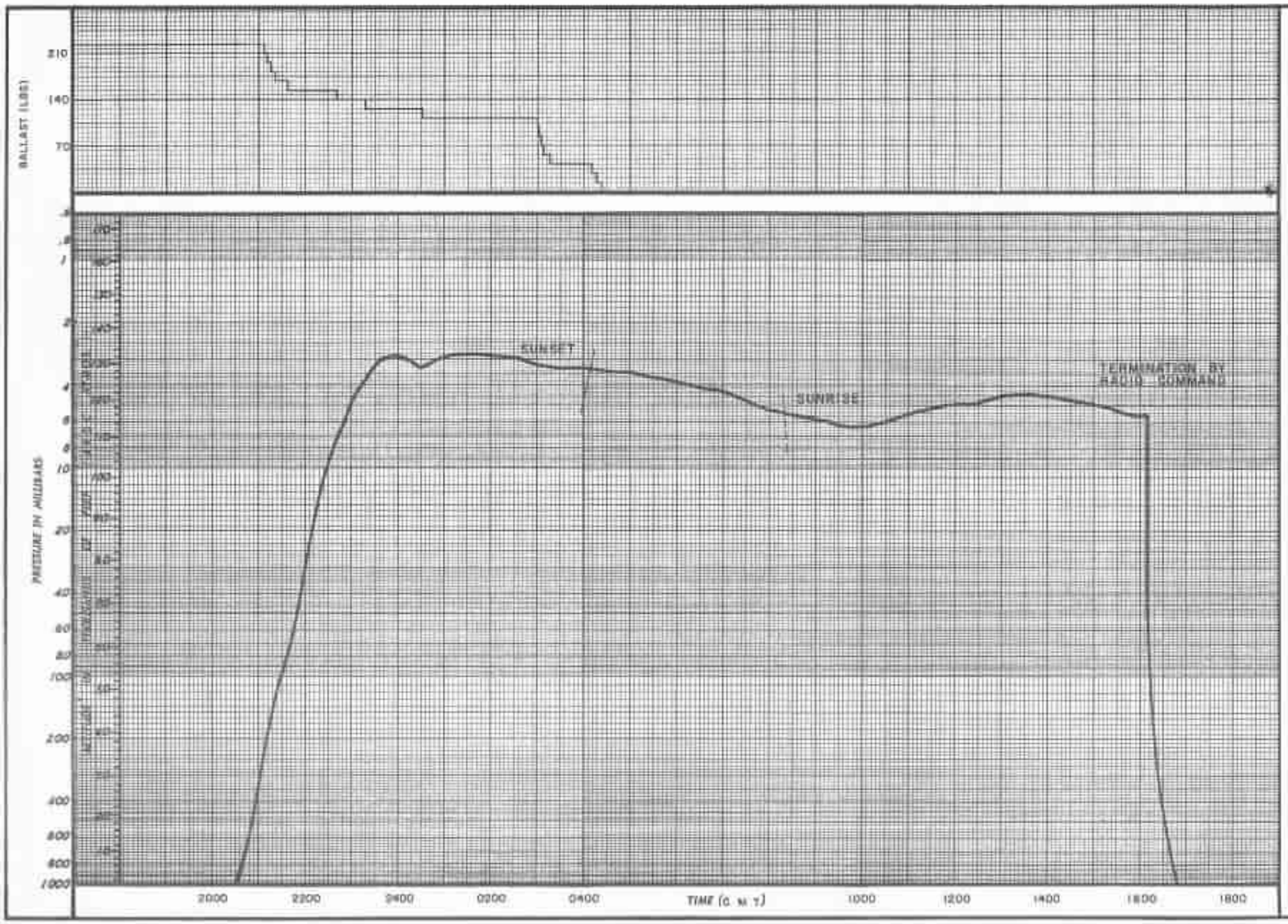
ONR/Code 421



FLIGHT NO. 1335

DATE: 29 JULY 72

FOR: U OF MD. & CALGARY

BALLOON

TYPE: NSC

VOL: 10.6×10^6 FT^3

MATL: 0.5 MIL POLY
0.7 MIL CAP

WT: 1074 LBS

LOAD FACTORS

PAYLOAD:	936
GROSS LD:	2010
FREE LIFT:	321
BALLAST:	225

RAVEN industries, inc.

DR.

CHK.

APPR.

B. Cape Girardeau, Missouri Program

Two scientific groups, the Washington University and the University of New Hampshire, desired to fly experiments from a southern location with a geomagnetic latitude different from that of Fort Churchill. The desired GV cutoff line ran through southern Kentucky to mid Missouri (See map).

Originally, Paducah, Kentucky, was selected as a tentative site. After a thorough survey of the area along the cutoff line, Cape Girardeau, Missouri was selected as the launch site. The airport had adequate launch space, as well as building space for experimenters to assemble the experiments.

By early August 1972, the program included three additional experiments for a total of six flights. In view of the overall flight requirements, it was necessary to be on site prior to wind reversal in order to fly the balloons which required a trajectory to the west.

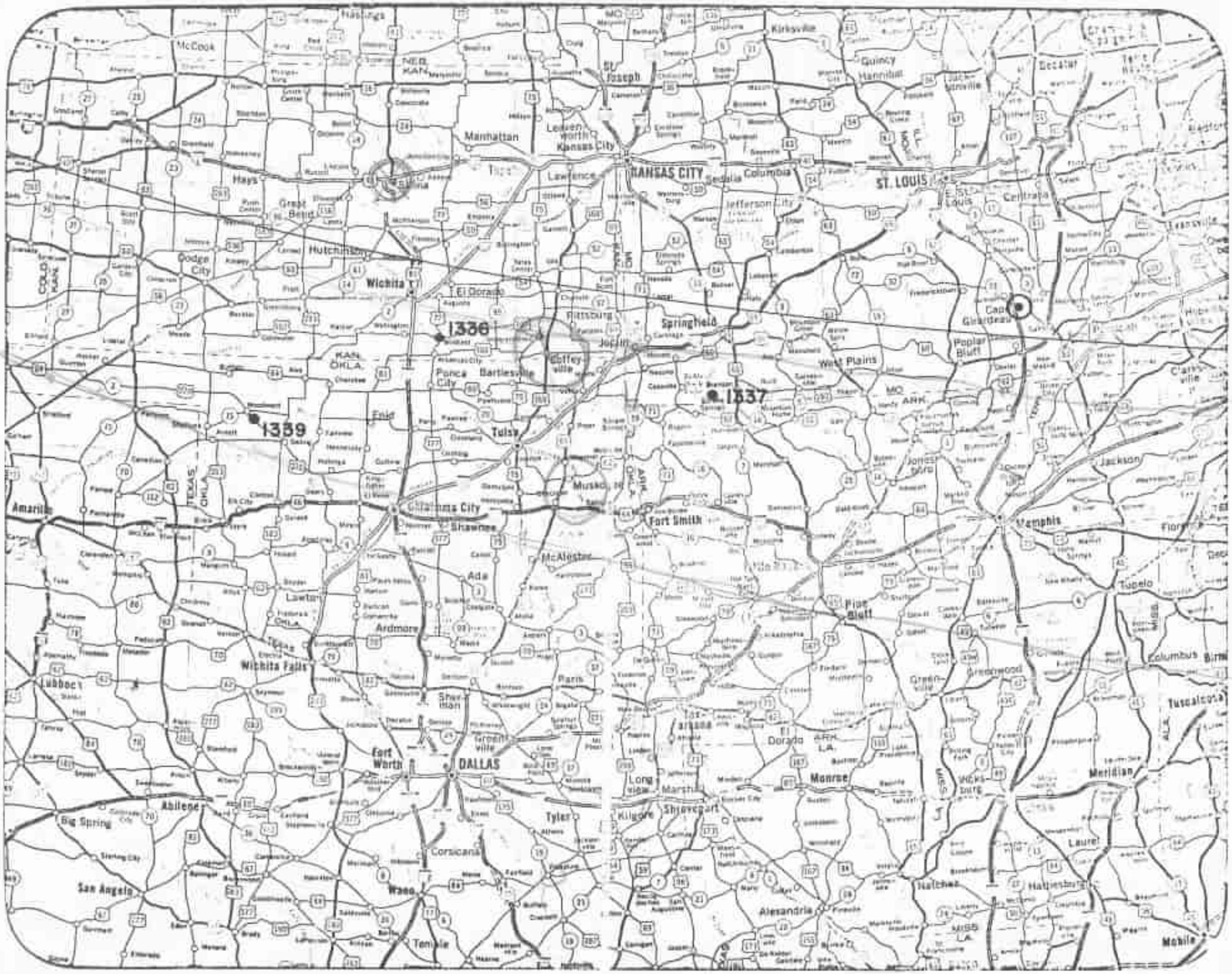
Helium for the program was shipped to Cape Girardeau in three Navy helium trailers from the Minneapolis Helium Pool, one trailer and a rail tank car from the Bureau of Mines, Amarillo, Texas.

The following scientific groups participated in the Cape Girardeau Program: University of New Hampshire, Professor John Webber; Washington University, St. Louis, Dr. Martin Israel & Dr. Joe Klarmann; University of Chicago, Professor Peter Meyer; University of California (Riverside), Professor Stephan White; Goddard Space Flight Center, Dr. Ormes; Rice University, Dr. Hugh Anderson; and Atomic Energy Commission, Mr. Peter Raft.

This program, like the Churchill Program, was monitored by ONR Field Representatives, who provided liaison between the project and the

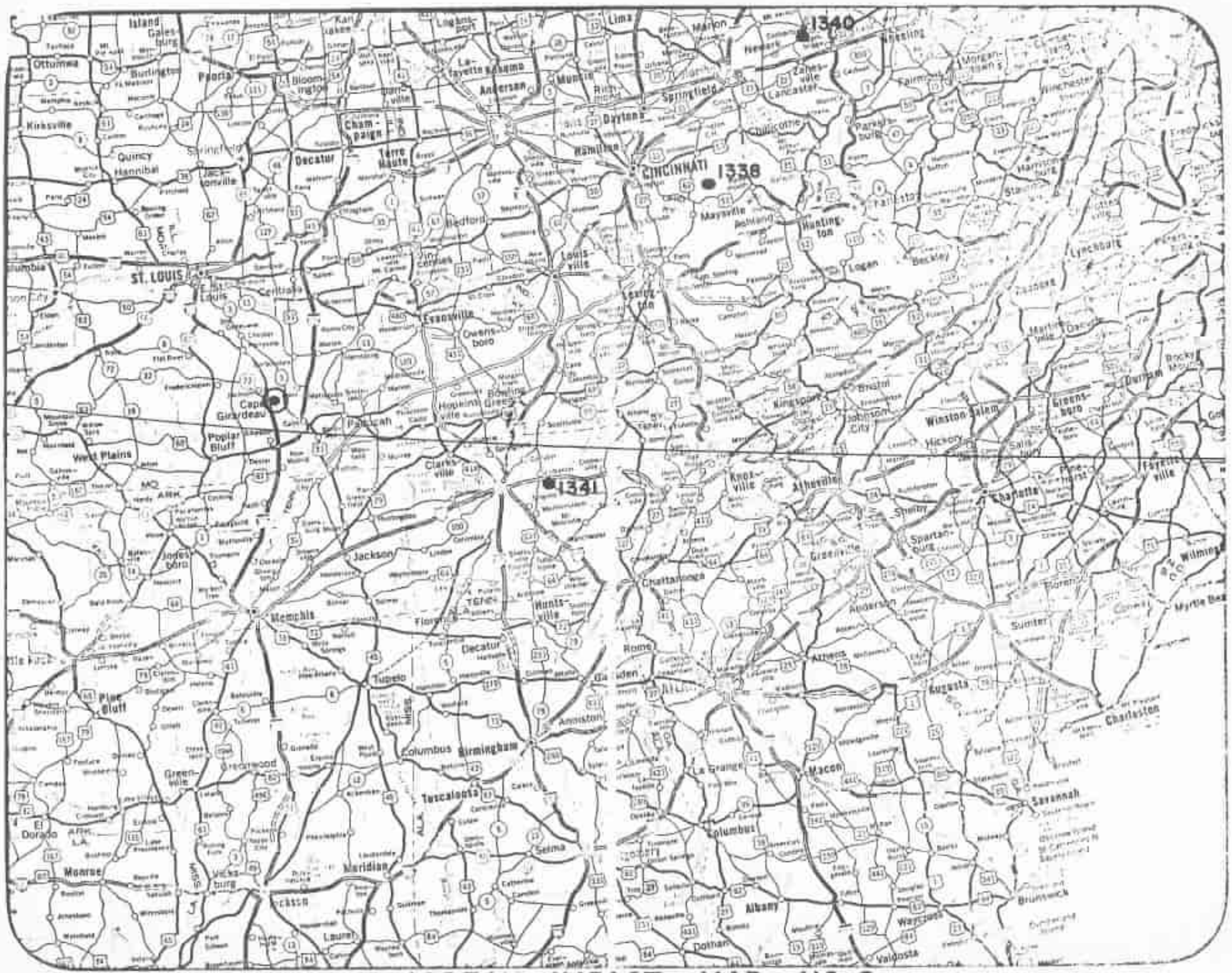
various military agencies, as well as serving as project meteorologist and forecaster.

Mr. Walter F. Martin, Physical Scientist, ONR Washington, D.C., and Commander W.F. Cross of the Minneapolis Field Office, were on the site during the first week, after which time ONR Representative Mike O. Evanick assumed the monitor duties until the end of the program.



CAPE GIRARDEAU IMPACT MAP NO. I

106



CAPE GIRARDEAU IMPACT MAP NO. 2

1336 - FLIGHT DESCRIPTION

UNIVERSITY OF NEW HAMPSHIRE
11 September 1972
Professor John Webber
Rice University, Houston, Texas
Dr. Hugh Anderson
Atomic Energy Commission, Peter Raft

This was the first flight of the series and included three separate experiments. The largest being the University of New Hampshire, with two hitchhike ion chambers from Rice University and the Atomic Energy Commission.

The New Hampshire experiment was the same as described under Flight 1324, with the exception of the low energy detector which was replaced with a Cerenkov detector.

The main support frame work facilitated attachment of the two ion chambers, one of which used a chart recorder to store data, while the data from Rice's experiment was telemetered via the Raven telemetry link. Data from the University of New Hampshire experiment was telemetered over a separate data link provided by New Hampshire.

Raven instrumentation provided ranging, pressure data, ballast drops, and termination.

A 49 foot solid, flat canopy parachute provided a terminal velocity of 19 to 23.5 feet per second.

The balloon provided was a Winzen 11.6 MCF, constructed of a 0.7 mil shell with a 0.9 mil cap, and 300 pound test tapes.

A smooth and timely launch was accomplished in calm winds on September 9th. Ascent was normal with no problems. Telemetry indicated experiments were performing properly.

After 13-1/2 hours at a ceiling of 132,000 to 135,000 feet, the flight was terminated by the Cessna 206 tracking aircraft and the gondola landed six miles southwest of Arkansas City, Oklahoma.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

1. Company Raven Ind. Inc. Flight Number 1336 Director Fulkerson
2. Scientist Webber Group U of N. Hampshire Date/Time 8-11-72 / 0705 Z
3. Launch: Site Cape Girardeau, Mo. Technique/Launch Veh. Dynamic M-36
4. Wx: Clear 2GF 66°F Calm SLP-1020.0 Cross Wind Angle 5°
   (Sky-Temp-Wind-Pressure)

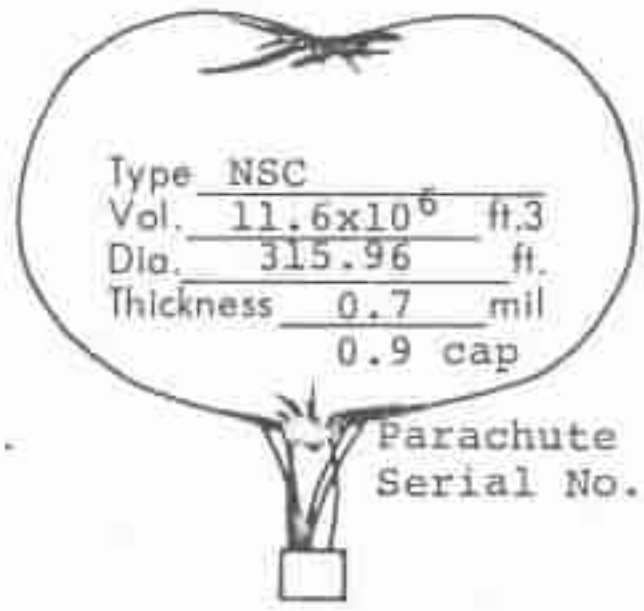
   Trop (Coldest) Ht. 50,000 ft. Temp --- °C Inflation Start 0630 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 500 ft.
5. Balloon: Theoretical 2.9 - 2.6 Mbs. 132.0 - 135.0 K ft. How Determined? MFG Curve

   Ceiling: Actual 3.05 Mbs. 131.0 K ft Transducer
6. Ascent: Surface to Trop. 847 fpm Trop. to Ceiling 526 fpm
7. Flight Duration: Total 17 hrs. 40 min. At Ceiling 13 hrs. 23 min.
8. Termination: Time 0001 Z Altitude 127.0 K ft. Cause R/C - 206
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 8-12-72 / 0045 Z Location 97° 10' W 36° 58' N
    6 miles SW Arkansas City, Kansas
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
250.7	Telemetry	19
149.4	Communications & Command	19

12. Balloon: Code Number SF 315.96-070-NSC-02 Serial Number 5



WEIGHTS

Balloon	1,442
Parachute & Rigging	53
Timer & Instrumentation Raven	58
Ballast	300
Scientific Package	462
Other Crush Pad	40
Other	
Gross Weight	2,355
Free Lift 14%	330
Gross Inflation	2,685
Helium used (cu. ft.)	41,617

13. Flight Failures
    (Nature of flight failures - if any)
14. Comments Hitch Hike (Hugh Anderson) (Pete Raft-AEC)
    (Significant factors concerning the operation)

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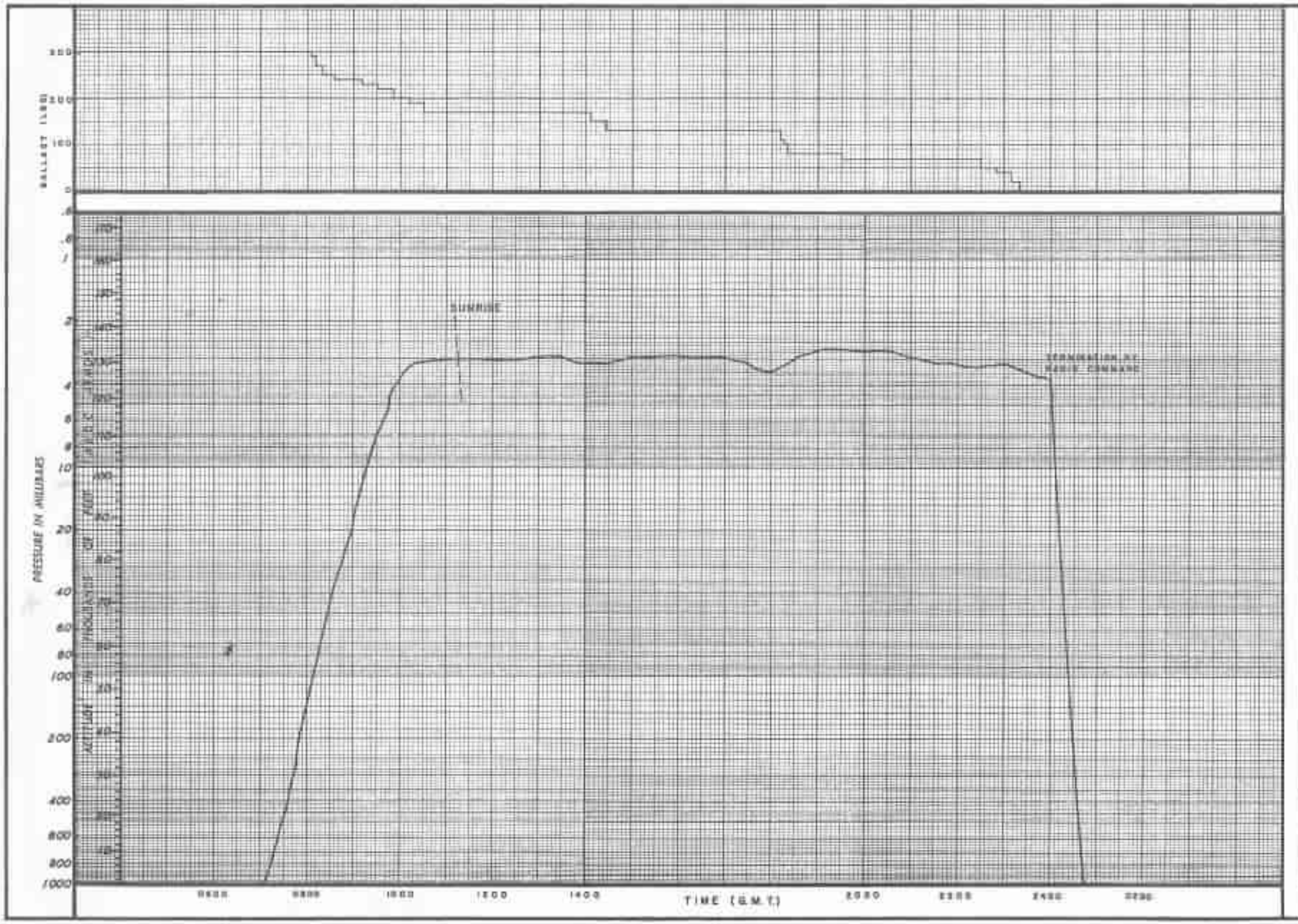
ONR/Code 421



FLIGHT NO. 1336

DATE: 9-11-72

FOR: U. of N. HAMP.

BALLOON

TYPE: NSC

VOL: 11.6×10^6 FT.^{3}

MATL: 0.7 MIL/0.9 CAP

WT: 1442

LOAD FACTORS

PAYLOAD: 913

GROSS LD: 2355

FREE LIFT: 330

BALLAST: 300

RAVEN industries, inc.

DR: _____

CHK: _____

APPR: _____

1337 - FLIGHT DESCRIPTION

WASHINGTON UNIVERSITY
13 September 1972
Dr. M. Israel - Dr. J. Klarman

Washington University was responsible for original planning of the Cape Girardeau program. Funding for the flight was provided by NASA.

The experiment was enclosed in an aluminum sphere 59-3/8 inches in diameter. Power supplies, photo barographs, and balloon control instruments are positioned outside the sphere on a support frame which serves both as a carrying stand and support frame for honeycomb impact cushion. The entire gondola is than covered with a wall of six-inch thick styrofoam.

The gondola has been flown by Raven on previous flights from Sioux Falls, having been launched once from a crane and several times from the Office of Naval Research launch truck.

Washington University technicians provided both sets of launch rigging, however, it was more practical from a scheduling viewpoint to launch with the truck.

Raven instrumentation, in addition to the normal requirements, provided four command channels for Power Switch, IC Test, Coincidence Set, and Discriminator.

A smooth and timely launch was performed on the evening of 13 September, in 9 mph winds. The ascent progressed at 1000 fpm to the tropopause with approximately 60 pounds of ballast expended. Prior to reaching a ceiling of 3.6 mbs, 238 more pounds of ballast was expended.

The balloon traveled westerly on winds of six to eight knots. After drifting 170 miles west southwest of Cape Girardeau, the flight was allowed to be terminated by timer.

The impact area was a forest north of Bull Shoals Lake. Recovery crews reached the gondola and recovered the parachute and balloon instrumentation. The gondola had landed in a ravine which made recovery impossible by any means except helicopter.

The experiment, left intact, weighed approximately 1380 pounds, which was too heavy for a bell U-1-A B Model provided by the Missouri National Guard from Springfield, Missouri. After several days, the Office of Naval Research office arranged to have a giant Skycrane helicopter from Forbes Air Force Base, Kansas, lift the gondola out of the woods.

The gondola was loaded on the recovery trailer and taken directly to the Washington University's lab in St. Louis.

Scientists reported the experiment had performed quite well with much interesting data.

All flight requirements were met, with the exception of the trajectory which was slightly south of the line of cut off.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1337 Director Fulkerson
2. Scientist Klarman - Israel Group Washington Univ. Date/Time 8-14-72 / 0134 Z
3. Launch: Site Cape Girardeau, Mo. Technique/Launch Veh. Dynamic M-36
4. Wx: Clear 82°F 210° 9 MPH SLP-1015.7 Cross Wind Angle 0°
   (Sky-Temp-Wind-Pressure)

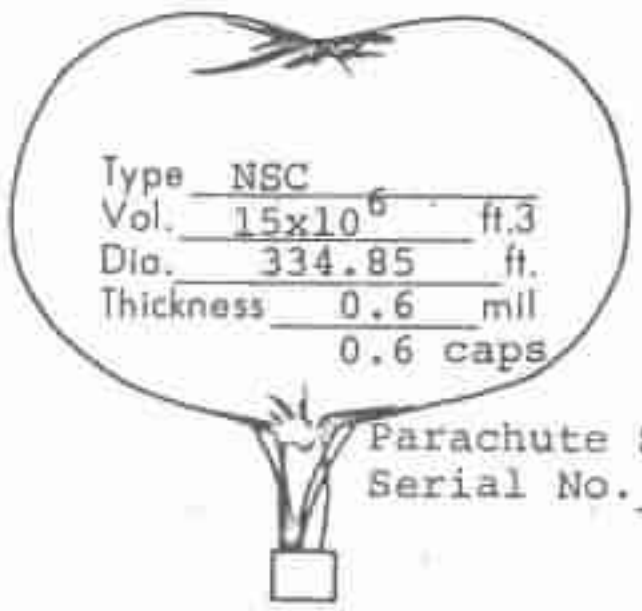
   Trop (Coldest) Ht. 50,000 ft. Temp ____ °C Inflation Start 0055 Z

   Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.
5. Balloon: Theoretical 3.25 - 2.85 Mbs. 129.2 - 132.5K ft. How Determined? MFG Curve

   Ceiling: Actual 3.7 Mbs. 126.5K ft Transducer
6. Ascent: Surfact to Trop. 1020 fpm Trop. to Ceiling 584 fpm
7. Flight Duration: Total 22 hrs. 40 min. At Ceiling 18 hrs. 51 min.
8. Termination: Time 2325 Z Altitude 126.5K ft. Cause Timer
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 8-15-72 / 0014 Z Location 92° 50'W 36° 31'N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	24.0
149.4	Communications & Command	24.0

12. Balloon: Code Number SF 334.85-060-NSC-05 Serial Number 36



WEIGHTS

	Balloon	1,648
	Parachute & Rigging	87
Timers	Instrumentation Raven	60
	Ballast	513
	Scientific Package	1,380
	Other Crush Pad	14
	Other	
	Gross Weight	3,702
	Free Lift	518
	Gross Inflation	4,220
	Helium used (cu. ft.)	65,410

13. Flight Failures ____
    (Nature of flight failures - if any)
14. Comments ____
    (Significant factors concerning the operation)

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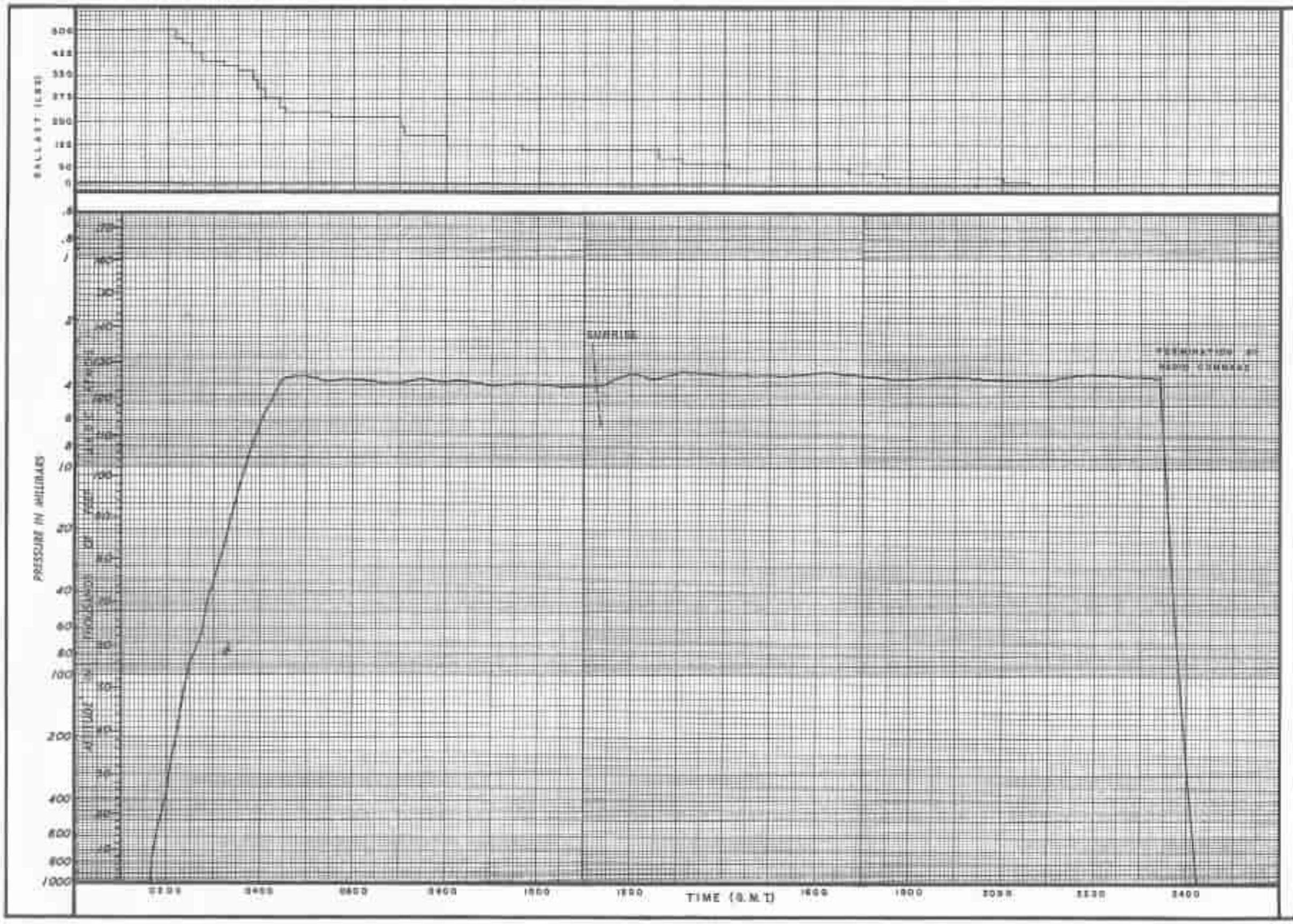


FLIGHT NO. 1337

DATE: 9-14-72
FOR: Washington Univ.

BALLOON

TYPE: NSC
VOL: 15 x 10^6 FT.^{3}
MATL: 0.6 MIL/0.6 CAP
WT: 1648

LOAD FACTORS

PAYLOAD: 2054
GROSS LD: 3702
FREE LIFT: 518
BALLAST: 500

RAVEN industries, inc.

DR.
CHK.
APPR.

1338 - FLIGHT DESCRIPTION

UNIVERSITY OF CHICAGO
14 September 1972
Professor Peter Meyer
Inar Juliusson

This was the largest experiment conducted by the University of Chicago. Having been flown previously from Palestine, Texas, Flight 1338 was the first time Raven Industries had an opportunity to launch the experiment.

The photos below show the size of the unit. The experiment was designed to measure nuclear composition of very high energy cosmic rays (20-100 GeV/n) and to obtain data on isotopic composition of the cosmic rays at low energy (1 GeV/n). Data is recorded on an on-board tape, as well as being transmitted to a University of Chicago telemetry station.

The instrument is tightly fitted into an aluminum capsule with all power supplies contained in exterior mounted boxes. An awkward framework consisting of five support struts with a 10 foot circular base provide the attachment points for five ballast hoppers, control instrumentation, timers, batteries, and crush pad. It seems the reason for the five "legs" was four legs would not have been enough and six would have been too many.

Originally scheduled to be launched by the anchor line technique, was later changed to crane launch because of increased weight. The anchor line launch cart served as a handling dolly for taking the assembled gondola out of the hangar to be mounted on the crane.

A parachute release mechanism between the parachute and gondola was incorporated into the system to prevent dragging after impact. However, due to a shortage of command channels, arming would have to have been accomplished simultaneously with another command, none of which was compatible with the arming sequence, so the release was flown but not used.

Preparation of the experiment was slow and awkward and required several hours to rig and mount on the crane.

The inflation of the 15 MCF balloon was accomplished in 24 minutes, with a smooth and timely launch being performed shortly afterward.

The ascent began at 600 fpm to 6,000 feet, where it leveled off at a steady 1000 fpm to the tropopause. Three hours and forty minutes after launch, the balloon reached an equilibrium of 4.9 mbs and remained at that level for 36-1/2 hours, at which time the flight was terminated probably by the timer. During descent the termination command and ballast dump was transmitted.

The flight descended on its 67 foot diameter parachute in about 41 minutes, landing south of Hillsboro, Ohio--sixty miles east of Cleveland.

The gondola landed near a road with the parachute dropping over telephone wires. The recovery crew followed package shutdown procedures but decided to wait until the following morning to complete the recovery. The next morning the recovery crew arrived on the scene only to find that a mysterious recovery crew had

already taken the flight batteries, and parachute, as well as the boxes containing the timer which terminated the flight.

Through efforts of the local police and FBI agents, the parachute was later returned.

Most probable cause for the early termination was improper setting of the timer while making last minute flight line changes.

The gondola was in reasonable condition after the flight except for its many legs which were damaged sufficiently, to render them as scrap.

The gondola was reworked and ready for flight in a few days.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1338 Director Fulkerson
2. Scientist Meyer-Juliusson Group U of Chicago Date/Time 9-15-72/ 0354 Z
3. Launch: Site Cape Girardeau, Mo. Technique/Launch Veh. Dynamic - Crane
4. Wx: Clear 70°F 340° 4 MPH SLP-1018.6 Cross Wind Angle 0°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 50,000 ft. Temp --- °C Inflation Start 0305 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 600 ft.

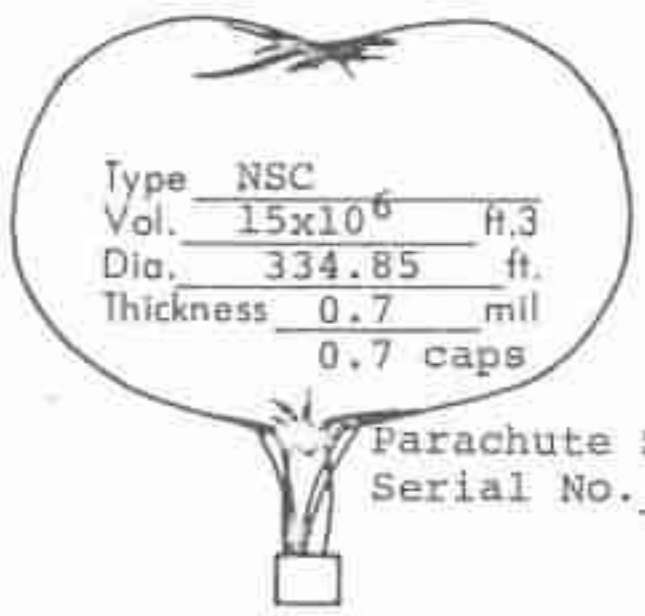
5. Balloon: Theoretical 4.65 - 3.85 Mbs. 120.3 - 124.9 K ft. How Determined? MFG Curve

Ceiling: Actual 4.9 Mbs. 119.0 K ft Transducer

6. Ascent: Surfact to Trop. 893 fpm Trop. to Ceiling 418 fpm
7. Flight Duration: Total 40 hrs. 53 min. At Ceiling 36 hrs. 34 min.
8. Termination: Time 2009 Z Altitude 119.0 K ft. Cause Timer
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 9-16-72/ 2047 Z Location 83° 36'W 38° 58'N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
250.7	Telemetry	43.0
149.4	Communications & Command	43.0

12. Balloon: Code Number SF 334.85-070-NSC-03 Serial Number 22



WEIGHTS

Balloon	1,975
Parachute & Rigging	120
Instrumentation Raven	50
Ballast	1,000
Scientific Package	1,655
Other Crush Pad	17
Other Batteries	47
Gross Weight	4,864
Free Lift 14%	681
Gross Inflation	5,545
Helium used (cu. ft.)	85,947

13. Flight Failures
(Nature of flight failures - if any)

14. Comments
(Significant factors concerning the operation)

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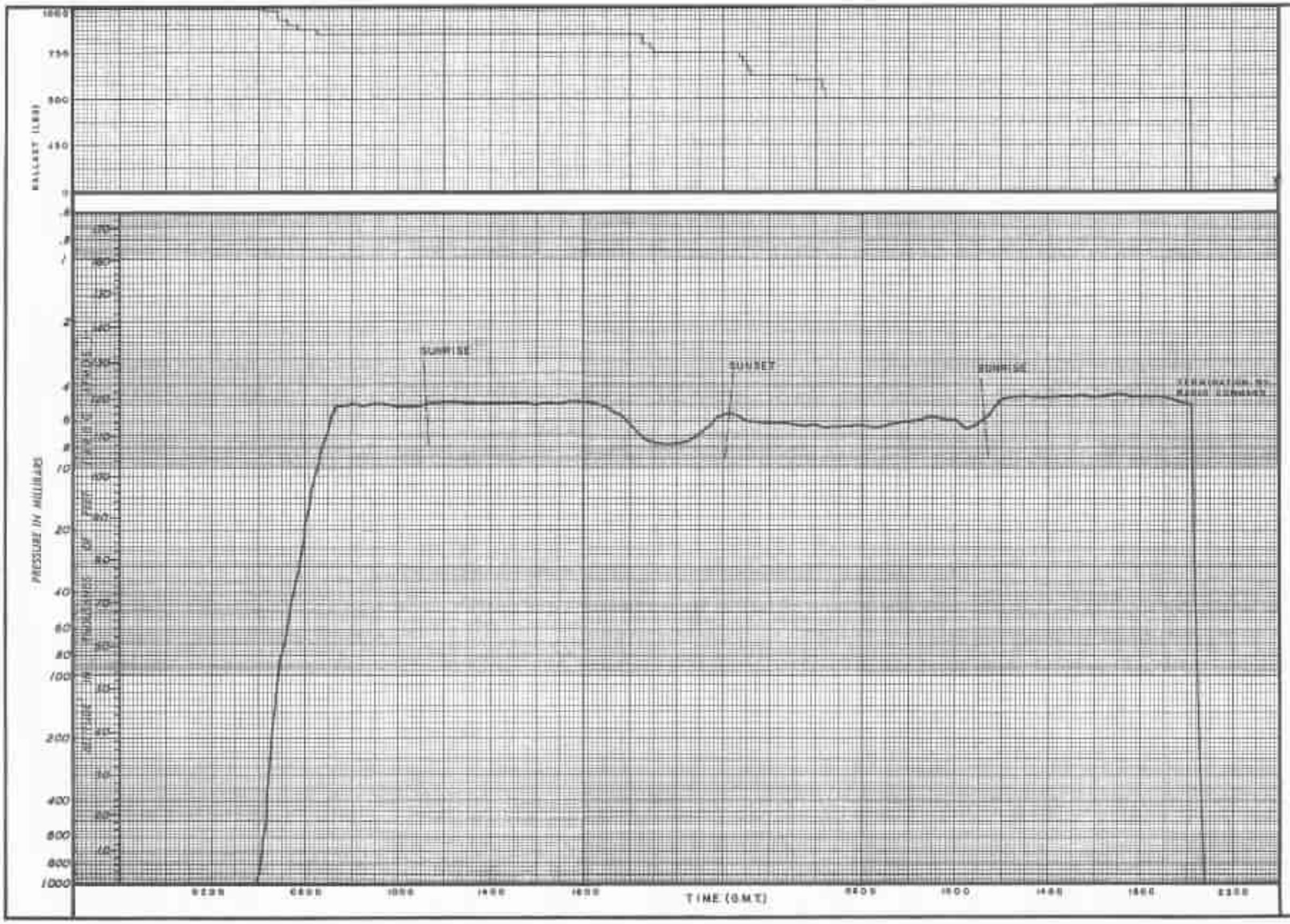
ONR/Code 421



FLIGHT NO. 1338

DATE: 9-15-72

FOR: U. OF CHICAGO

BALLOON

TYPE: NSC

VOL: 15×10^6 FT.^{3}

MATL: 0.7 MIL/0.7 CAP

WT: 1975

LOAD FACTORS

PAYLOAD:	2889
GROSS LD:	4864
FREE LIFT:	681
BALLAST:	1000

RAVEN industries, inc.

DR._____

CHK._____

APPR._____

1339 - FLIGHT DESCRIPTION

UNIVERSITY OF CALIFORNIA - RIVERSIDE
19 September 1972
Professor Stephan White

The University of California's experiment was basically the same configuration as flown from Fort Churchill on Flight 1329. California technicians performed a thorough checkout of the experiment prior to final buttoning-up of the gondola. Attaching of the styrofoam insulation jacket had to be completed prior to installation of the ballast hopper and control instruments which were attached outside the jacket.

Balloon control instrumentation was similar to the Churchill flight, except that the battery power was increased to provide longer flight duration. The increased battery capacity made it necessary to relocate the transmitter from a location near the bottom of the container to the top of the instrument canister. To accommodate the transmitter in the new position, insulation in the top cover was minimized.

The parachute provided for the descent was a flat, circular 64 foot diameter, calculated to provide a landing velocity of 24 feet per second. A smooth launch was performed on 19 September. The flight progressed normally.

University of California's data was being received but the signal was noisy, making the data practically useless. A quick survey of the hangar and ramp area located the problem--a tractor being used on a construction project was the culprit. The contractor agreed to delay the operation of the tractor for several hours to enable Raven technicians to replace the ignition harness with a new set of carbon core wires. Once done, the noise was eliminated.

After 22 hours, the receiver in the control package began intermittent operation, and shortly afterward, failed to respond to command tones both for ballast and range.

The C-47 enroute to Libral, Kansas, was diverted to Dodge City because of weather. The portable telemetry station was set up, but telemetry signal strength was

low and noisy. No useful data was obtained.

The following morning the recovery crew contacted the Program Manager who instructed the recovery aircraft crew to locate the balloon, and as soon as it was practical...to terminate the flight, the principal scientist was advised of the decision to terminate the flight. He requested the flight be allowed to continue for as long as possible. The recovery crew had departed and could not be reached. The flight was terminated at 1448Z.

The balloon's location was west of a front and was visible through occasional breaks in clouds.

The telemetry signal was weak prior to termination and eratic during descent. The tracking aircraft was unable to get a needle indication. The signal was lost after about twelve to fourteen minutes.

The balloon was located, but the parachute wasn't located until the following day, when a rancher located the gondola and parachute in his pasture.

The parachute had failed to inflate and the experiment free fell. The entire system was damaged beyond salvage. The parachute was returned to Cape Girardeau and inspected.

Due to the condition of the parachute, inspection was difficult. Some of the lower canopy was missing, while the top was twisted very tightly. After untwisting, the top vent with items of hardware, was located.

Both squib cannons with wires and plugs and the load link were twisted into the canopy approximately ten feet from the skirt. The hardware items at the vent had sufficient weight and protrusions to snag the canopy. Of the hardware items on top of the parachute, the two cannon plugs were most conducive to snagging the canopy due to two small clamping screws which protrude 3/8 inches.

The weight of the hardware on top of the parachute is approximately five pounds. At termination, the parachute which is under tension, has a tendency to snap back or rebound items into the canopy.

Due to the descent time of approximately fourteen minutes and the eratic signal, it is believed the parachute became fouled seconds after termination.

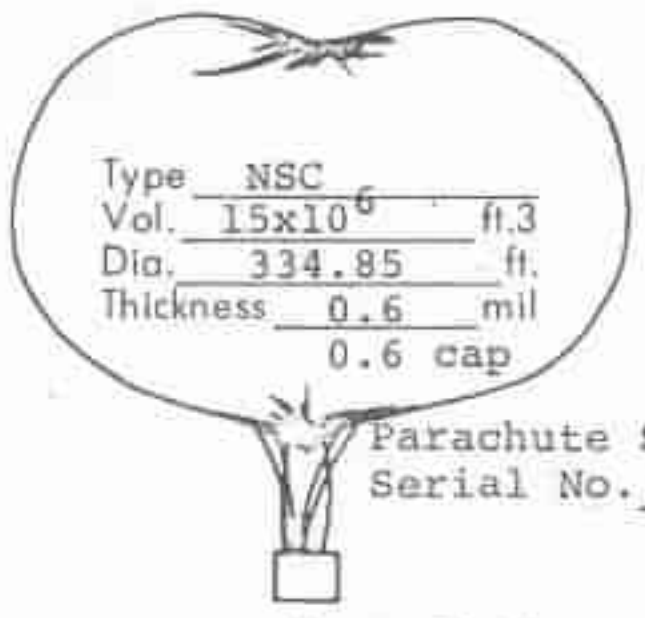
SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1339 Director Fulkerson
2. Scientist White Group U of California Date/Time 9-19-72/ 0912 Z
3. Launch: Site Cape Girardeau, Mo. Technique/Launch Veh. Dynamic M-36
4. Wx: Clear 73°F 130° 4 MPH SLP-1001.8 Cross Wind Angle 10°
   (Sky-Temp-Wind-Pressure)
   Trop (Coldest) Ht. 50,000 ft. Temp --- °C Inflation Start 0835 Z
   Hrs. Sunshine on Bubble --- Train Length (Layout) 550 ft.
5. Balloon: Theoretical 3.85 - 3.25 Mbs. 126.0 - 129.8 K ft. How Determined? MFG Curve
   Ceiling: Actual 3.7 Mbs. 127.0 K ft Transducer
6. Ascent: Surfact to Trop. 926 fpm Trop. to Ceiling 581 fpm
7. Flight Duration: Total 29 hrs. 50 min. At Ceiling 26 hrs. 33 min.
8. Termination: Time 1448 Z Altitude 124.0 ft. Cause R/C C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 9-20-72/ 1502 Z Location 99° 10' W 36° 19'
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
253.8	Telemetry	31.0
149.4	Communications & Command	31.0
256.2	Telemetry	31.0

12. Balloon: Code Number SF 334.85-060-NSC-05 Serial Number 35



WEIGHTS

Balloon	1,598
Parachute	67
Instrumentation Raven	65
Ballast	600
Scientific Package	1,430
Other Crush Pad	32
Other Timers	10
Gross Weight	3,802
Free Lift 14%	532
Gross Inflation	4,334
Helium used (cu. ft.)	67,177

13. Flight Failures Parachute failure, free fall.
    (Nature of flight failures - if any)
14. Comments
    (Significant factors concerning the operation)

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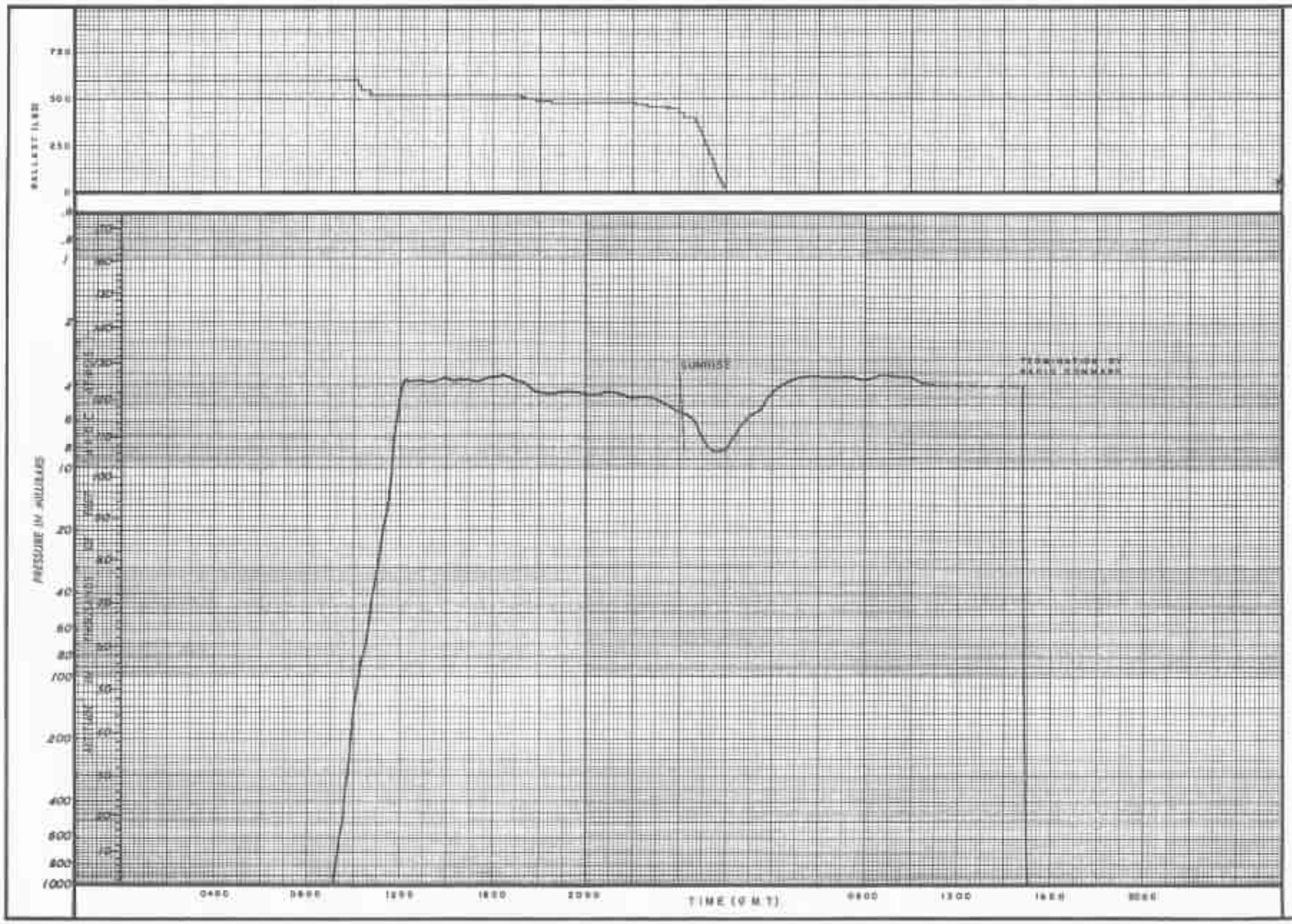
ONR/Fld Rep/Minn
ONR/Code 421



FLIGHT NO. 1339

DATE: 9-19-72

FOR: U. of CALIFORNIA

BALLOON

TYPE: NSC

VOL: 15×10^6 FT.^{3}

MATL: 0.6 MIL/0.6 CAP

WT: 1598

LOAD FACTORS

PAYLOAD:	2204
GROSS LD:	3802
FREE LIFT:	532
BALLAST:	600

RAVEN industries, inc.

DR.

CHK.

APPR.

1340 - FLIGHT DESCRIPTION

UNIVERSITY OF CHICAGO
28 September 1972
Professor Peter Meyer
Inar Juliusson

With the exception of the batteries, battery boxes and one ballast hopper, the gondola was the same as Flight 1338.

Since the previous parachute was no longer available, a replacement, 67 foot white parachute, was used.

The flight was scheduled to be aloft for 63 hours. The launch conditions were very good with the wind steady at five mph, however, at the time of launch the wind was 90° to the layout which caused the launch to be something other than routine. As the balloon was released, it drifted off to the west instead of south toward the launch vehicle. The crane was moved south to the first intersection of the runway than turned west, chasing the balloon, which was leaning at 60°. As the crane accelerated to its maximum speed of twenty mph, the gondola was fired loose from the crane, resulting in a smooth launch.

Four hours and twenty minutes later the flight leveled off at 4.45 mbs (121,400 feet). Program management and the Office of Naval Research Field Representative decided it was best to terminate the flight after about forty hours since it was moving out of range and it would have had to continue through the night without ballast. Forecast trajectory would have placed the flight over the Washington, D.C. area by the following morning.

The Tracking C-47 terminated the flight east of Coshocton, Ohio.

Recovery was performed with the gondola being taken by truck, direct to the University's lab in Chicago.

With this flight, Chicago concluded its 1972 Skyhook Program at Cape Girardeau.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1340 Director Fulkerson
2. Scientist Meyer-Juliusson Group U of Chicago Date/Time 9-28-72 / 0741 Z
3. Launch: Site Cape Girardeau, Mo. Technique/Launch Veh. Dynamic - Crane
4. Wx: -X2 GF 66°F 110° 5 MPH SLP-1018.7 Cross Wind Angle 90°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 50,000 ft. Temp --- °C Inflation Start 0700 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 600 ft.

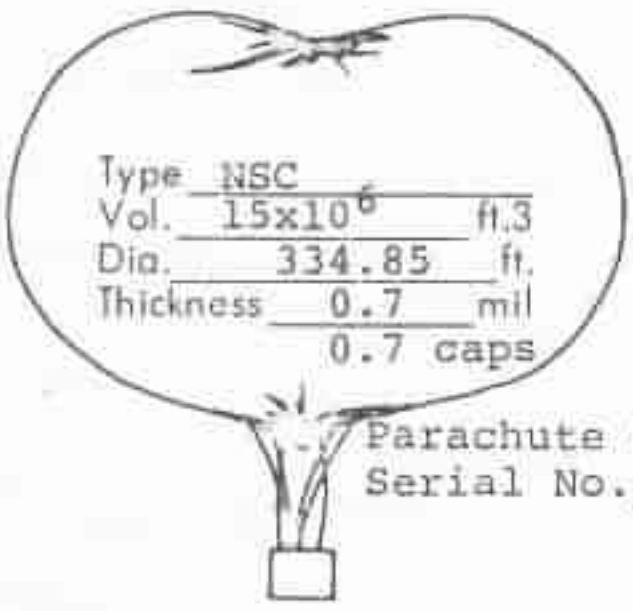
5. Balloon: Theoretical 4.4 - 3.7 Mbs. 121.7 - 126.0 K ft. How Determined? MFG Curve

Ceiling: Actual 4.5 Mbs. 121.4 K ft Transducer

6. Ascent: Surfact to Trop. 704 fpm Trop. to Ceiling 374 fpm
7. Flight Duration: Total 39 hrs. 04 min. At Ceiling 34 hrs. 13 min.
8. Termination: Time 2213 Z Altitude 115.0 K ft. Cause R/C C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 10-29-72 / 2245 Z Location 81° 53' W 40° 13' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	40.0
149.4	Communications & Command	40.0

12. Balloon: Code Number SF 334.85-070-NSC-05 Serial Number 34



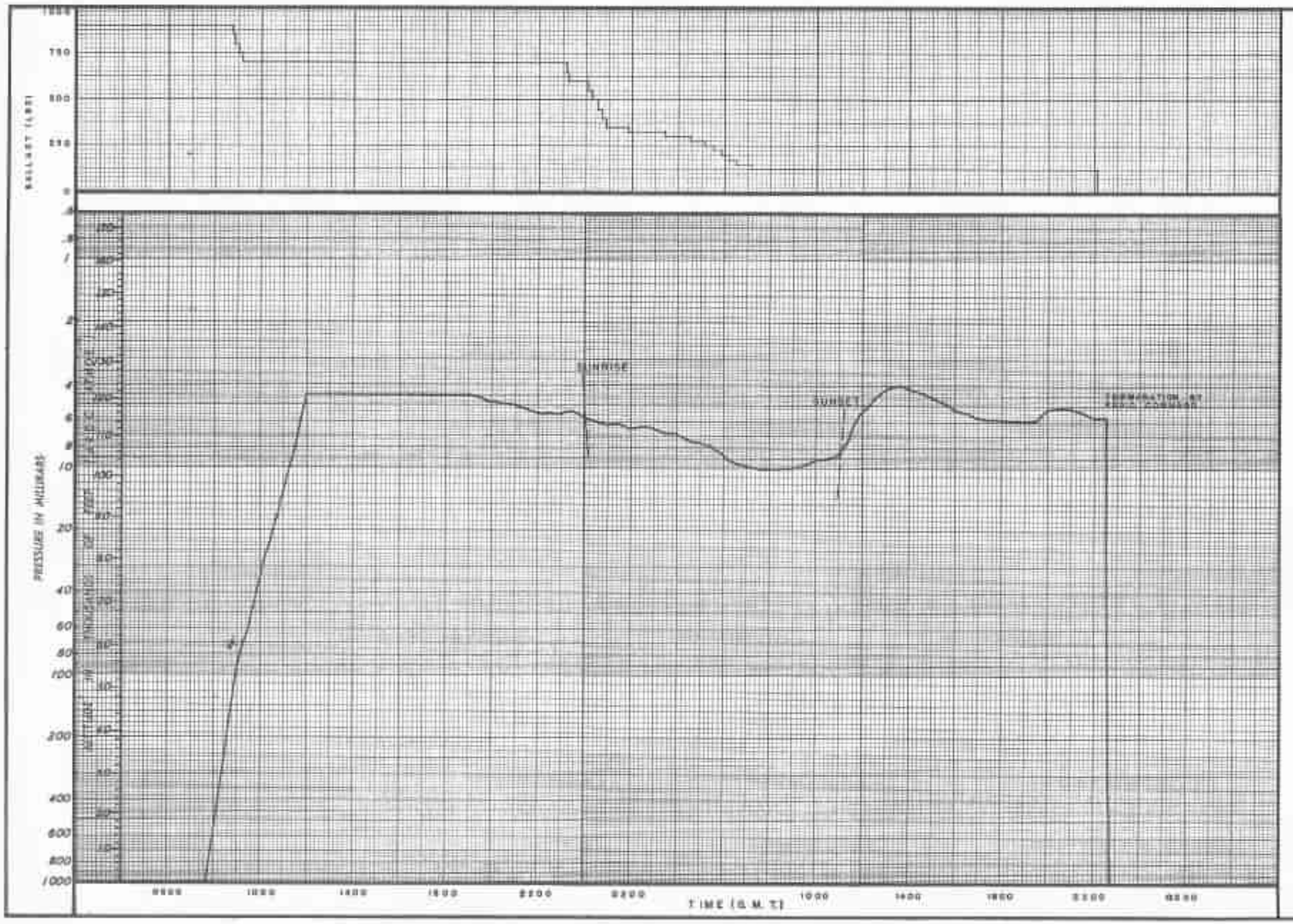
WEIGHTS

Balloon	1,879
Parachute	110
Instrumentation	50
Ballast	900
Scientific Package	1,604
Other	117
Other	17
Gross Weight	4,677
Free Lift	655
Gross Inflation	5,332
Helium used (cu. ft.)	82,646

13. Flight Failures
(Nature of flight failures - if any)

14. Comments
(Significant factors concerning the operation)

Copy to:
ONR/Fld Rep/Minn
ONR/Code 421



FLIGHT NO. 1340

DATE: 9-28-72

FOR: U. of CHICAGO

BALLOON

TYPE: NSC

VOL: 15×10^6 FT.^{3}

MAT'L: 0.7 MIL/0.7 CA

WT: 1879

LOAD FACTORS

PAYLOAD 2789

GROSS LD 4677

FREE LIFT: 655

BALLAST: 900

RAVEN industries, inc.

DR.

CHK.

APPR.

RAVEN industries, inc.

1341 - FLIGHT DESCRIPTION

GODDARD SPACE FLIGHT CENTER
1 October 1972
Dr. Ormes

The experiment was the same as flown on Flight 1320, May 16, 1972, with some minor changes in the internal structural supports which had been damaged during the first flight. For the second flight, a 100 foot parachute was used instead of the previous 83 foot ringsail. The area of the honeycomb crush pad was increased by about 15%.

The gross system weight of 7421 pounds was considered too high to utilize the Raven launch truck, so a local crane operator provided a suitable crane to which the necessary hardware was attached to perform the launch.

The gondola was delivered to Cape Girardeau by truck. The gondola had not been opened for several months during which time it was monitored and was in fine operational condition. Flight requirements called for 24 hours duration aloft.

On 1 October, the balloon was launched during four mph winds. Lift off was smooth and timely.

An initial ascent of 950 feet per minute was established shortly after launch and maintained to 30,000 feet after which time the rate decreased to 850 fpm. In an effort to keep the system moving, the command to drop ballast was transmitted, however, no indication was received that ballast was dropped--the ascent rate also indicated ballast was not being expended. This condition lasted for 200 minutes, after which performance returned to normal. Approximately 370 pounds ballast was expended during sunset on the balloon.

After 26 hours aloft, 22-1/2 of which was at ceiling, the flight was terminated by timer. The descending system, weighing 2800 pounds, landed 41 minutes later five miles southeast of Lebonon, Tennessee.

The experiment performed well throughout the flight, and the gondola suffered no impact damage.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN® industries, inc.

1. Company Raven Ind. Inc. Flight Number 1341 Director Fulkerson
2. Scientist Ormes Group GSFC Date/Time 10-1-72/ 1414 Z
3. Launch: Site Cape Girardeau, Mo. Technique/Launch Veh. Dynamic - Crane
4. Wx: Clear 43°F 4 MPH SLP-1010.8 Cross Wind Angle 0°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 48,000 ft. Temp --- °C Inflation Start 1325 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 700 ft.

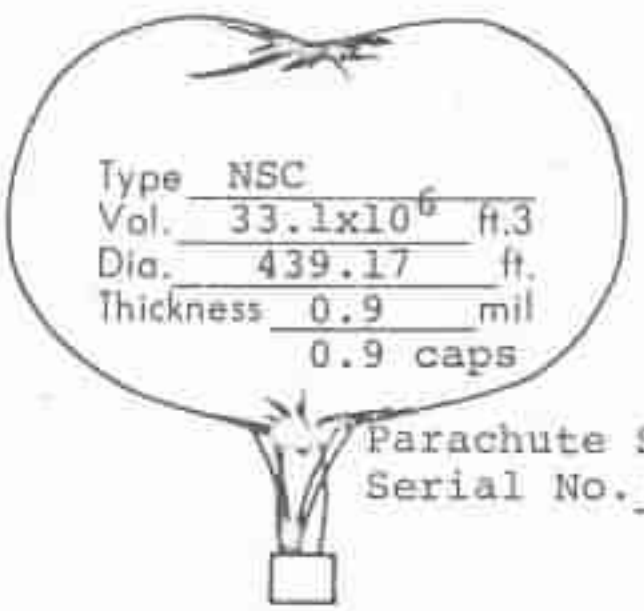
5. Balloon: Theoretical 3.1 - 2.9 Mbs. 130.0 - 132.3 K ft. How Determined? MFG Curve

Ceiling: Actual 3.5 Mbs. 127.3 K ft Transducer

6. Ascent: Surfact to Trop. 923 fpm Trop. to Ceiling 550 fpm
7. Flight Duration: Total 26 hrs. 26 min. At Ceiling 22 hrs. 29 min.
8. Termination: Time 1559 Z Altitude 130.0 K ft. Cause Timer
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 10-2-72/ 1640 Z Location 86° 15' W 36° 11' N
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
253.1	Telemetry	27.0
149.4	Communications & Command	27.0
250.7	Telemetry (Ormes)	27.0

12. Balloon: Code Number SF 439.17-090-NSC-01 Serial Number 2



Timers

WEIGHTS

Batteries & Xmitter	17
Balloon	3,789
Parachute	147
Instrumentation Raven.	64
Ballast	700
Scientific Package	2,538
Other Crush Pad	114
Other Spreader Cable	52
Gross Weight	7,421
Free Lift .12%	890
Gross Inflation	8,311
Helium used (cu. ft.)	128,820

13. Flight Failures
(Nature of flight failures - if any)

14. Comments
(Significant factors concerning the operation)

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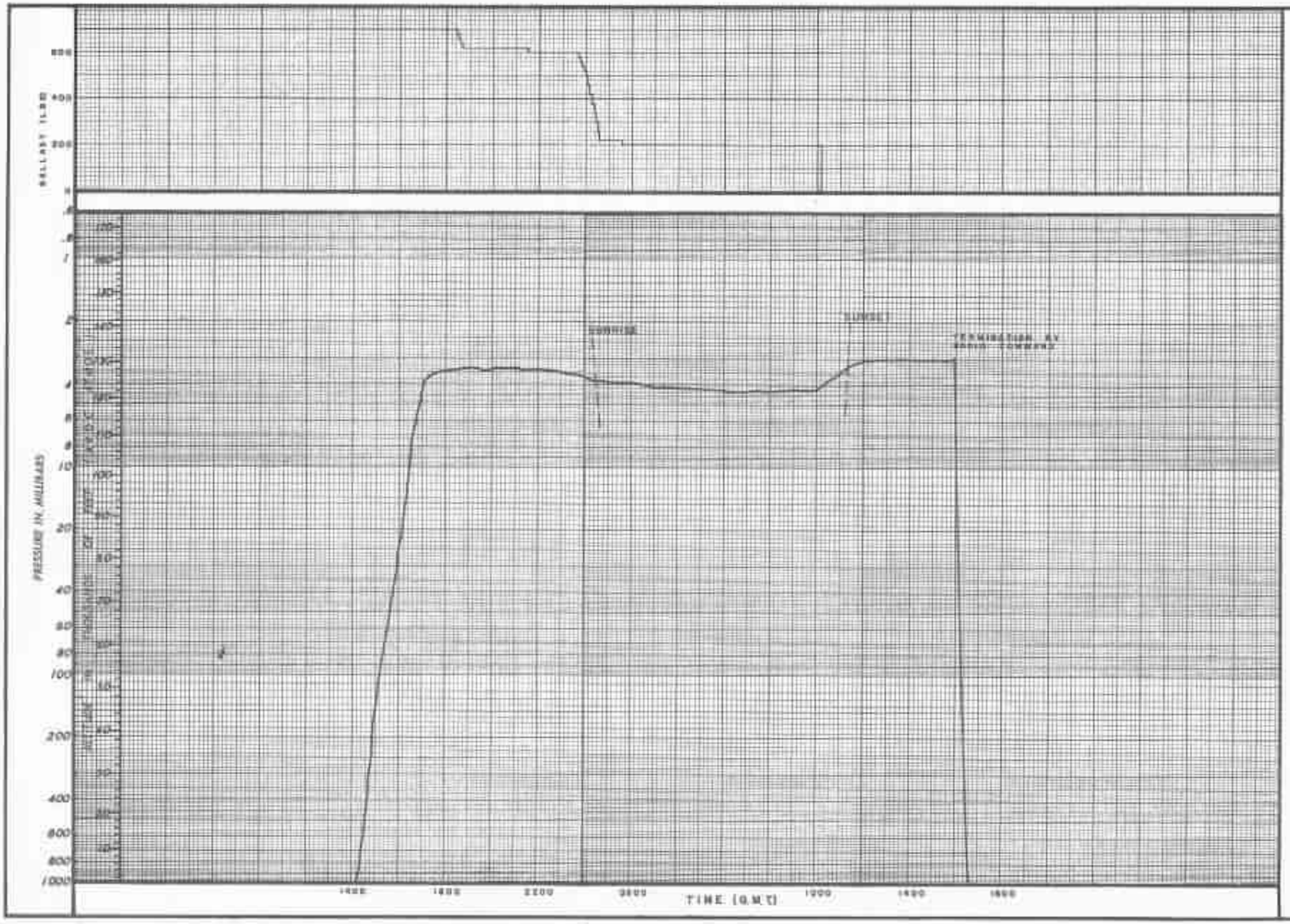
ONR/Fld Rep/Minn
CNR/Code 421



FLIGHT NO. 1341

DATE: 10-1-72

FOR: NASA/GSFC

BALLOON

TYPE: WSC

VOL: 33.1×10^6 FT.^{3}

MATL: 0.9 MIL/0.9 CAP

WT: 3789

LOAD FACTORS

PAYLOAD: 3632

GROSS LO: 7421

FREE LIFT: 890

BALLAST: 700

RAVEN industries, inc.

DR

CHK.

APPR.

RAVEN industries, inc.

C. Red Deer, Alberta Program

Two experiments were scheduled to be flown from Red Deer; both being from Goddard Space Flight Center at Greenbelt, Maryland.

The original launch site was to be Cold Lake, Alberta, and later changed to North Battleford, Saskatchewan. Since the gondolas were heavier than originally planned, it was decided to move to Red Deer where more facilities were available.

The Red Deer Airport is an ex-military training field with three sets of parallel runways and large parking ramps and taxi ways.

Adequate building facilities were provided by Sterling Aero Industries, Ltd. Sterling employees were most cooperative in assisting with hangaring of the C-47 and with the loading and unloading of equipment shipped to the airport.

A local contractor, Louis Victor, Ltd., provided a hydraulic crane for the launch vehicle. Raven provided a launch pin attachment which could be fitted to the crane in a matter of minutes.

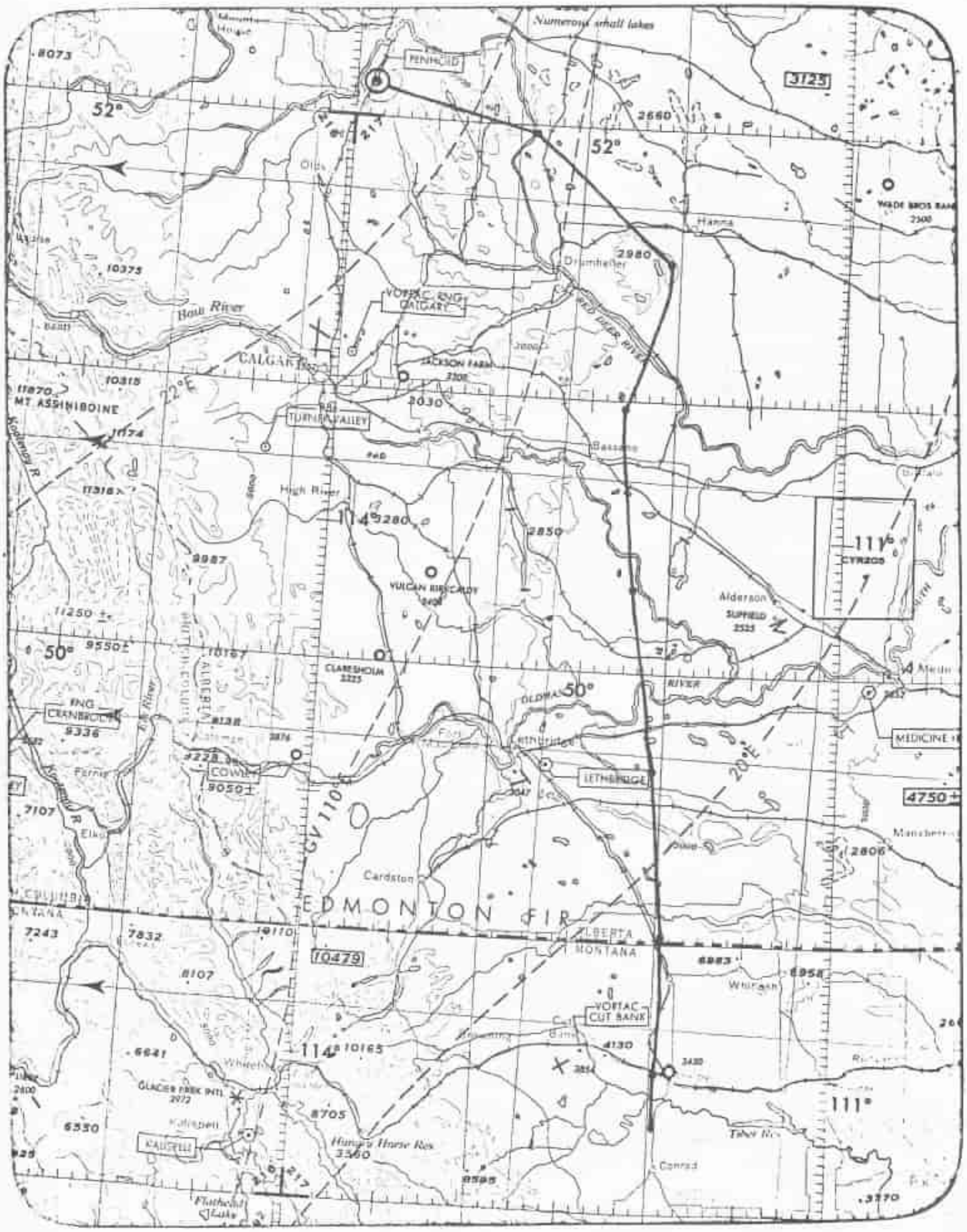
Weather data was available from the local station, which received its data from Edmonton. Forecasts were not as accurate as would have been desired. Apparently Red Deer's location in regard to the mountains to the west produces some rather unusual local conditions which are not predictable.

Additional upper wind data was obtained by radar tracking of 140D Kasam Balloons. Tracking was provided by the 43rd Radar Squadron, CFB, Penhold, under the direction of Major L. Brasseaur and his staff, which included Capt. Cliff Unger, Capt. Marv R. Sywyk, and Chief Warrant Officer Jones.

Before any launches were performed, it was necessary to clear the operation with ATC Edmonton, Mr. Parker Currie, Chief of ATC Edmonton, came to Red Deer to coordinate details of the balloon launches. As Chief of ATC Edmonton, Mr. Currie is very familiar with balloon flights, having handled all the balloon terminations launched from Fort Churchill over the

past few years. At Mr. Currie's request, a radio was placed in the Red Deer Tower for communications with the balloon tracking center, allowing ATC Edmonton to obtain position and altitude data in seconds by contacting Red Deer Tower.

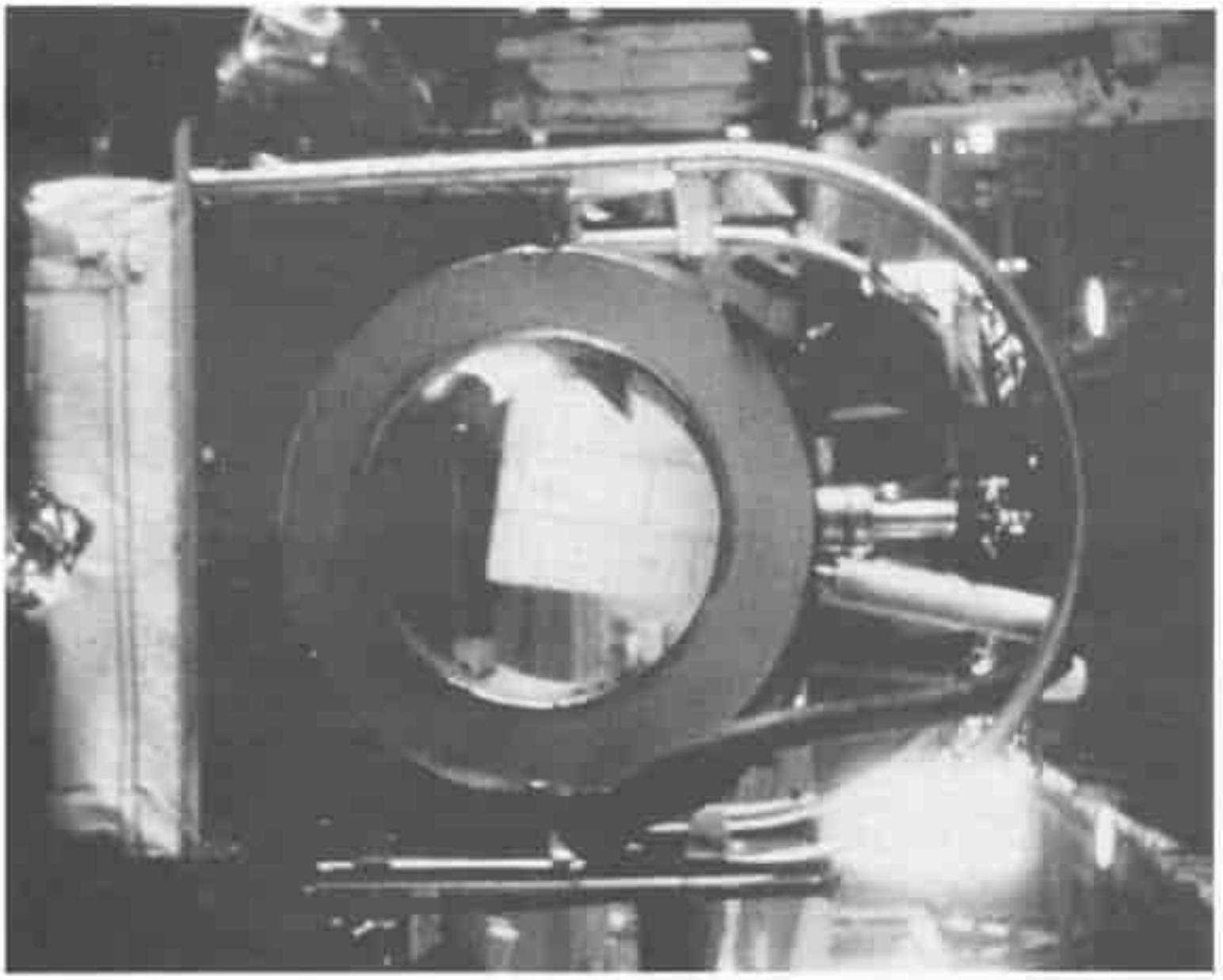
Since Red Deer is located between Edmonton and Calgary under two airways close liaison with ATC, Edmonton was of utmost importance. Mr. Currie's personal interest and enthusiasm, as well as that of his capable staff, resulted in excellent coordination with other airspace users.


Numerous small lakes
PENHOLD
3125
52°
2660
2980
Drumheller
VORTAC CALGARY
Bow River
CALGARY
10375
10318
11870
MT ASSINIBOINE
11316
11974
TURNER VALLEY
2030
High River
5280
2850
9987
YULCAN
11250 ±
9550±
10167
50°
CLARESHOLM
3223
RNG CRANBROOK
9336
9138
9228
COWLEY
9050±
7107
Elko
Cardston
EDMONTON FIR
7243
7832
10110
10479
8107
6641
Whitefish
GLACIER PARK INTL
2972
KALISPELL
6550
8705
Hungry Horse Res
3560
8595
Flathead Lake
MONTANA
ALBERTA
VORTAC CUT BANK
10165
4130
3430
Alderson
SUFFIELD
3325
LETHBRIDGE
MEDICINE HAT
4750+
2806
6983
6958
Whitlash
Conrad
3370
111°
114°
113°
110°
22°E
20°E
RED DEER IMPACT MAP

1342 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
10 October 1972
Dr. D.V. Reames

This experiment utilized an emulsion stack located in the field of a large superconducting magnet. This was Dr. Reames' second attempt with this experiment, the first having been flown from Churchill in 1969. The 1969 experiment failed on ascent. The magnet was damaged due to a water impact and could not be rebuilt.



The Red Deer Experiment was a new magnet with a new frame and telemetry system which provided temperature and pressure data. An externally mounted tank provided a steady supply of liquid nitrogen to the cooling jacket around the liquid helium jacket.

The magnetic field around the magnet prevented mounting the balloon control instruments or the ballast on the gondola.

Balloon instruments were positioned in the flight train 25 feet above the magnet and the ballast 25 feet below. All rigging in the field was nylon or stainless steel.

Due to the overall length of the system and the fact that the magnet was too strong to be near a launch truck, the anchor line launch technique was selected as the method of launch. The previous flight from Churchill was launched by this method.

The anchor line technique has some good qualities, as well as some poor ones. The technique normally imports less stress on the balloon, eliminating "capturing" the balloon. The gondola need not be released until 100 to 150 feet above ground and the system requires no special launch truck or crane.

An anchor line launch requires more personnel with more precise timing and coordination. Anchor line launches are not easily performed in cross winds beyond 20° to 30°.

The balloon provided for the flight was an 18.5 MCF with a 0.6 mil envelope and two 0.6 mil caps.

After several days of assembly and a thorough checkout, the experiment was working perfectly so the flight was scheduled for release on 20 October. Flight preparations were slow, requiring some two hours before inflation could be started.

At the time inflation was begun, the wind was 5° cross to the flight train. The Office of Naval Research Representative suggested re-laying out of the balloon in line with the wind direction. After some discussion, it was mutually decided by the Program Manager and Office of Naval Research Representative that 5° was not sufficient to warrant the additional delay.

Before inflation was completed, the wind shifted from 275° to 335°. At five mph this amount of cross wind would make the launch more difficult but not impossible. The gondola would

have to be moved in a direction perpendicular to the flight train, as well as toward the anchor truck. To minimize the distance traveled by the gondola before being lifted, the anchor line was deflected approximately 100 feet from the gondola.

At release the balloon rose normally for approximately 75 feet than began to drift off to the side of the flight train.

The anchor truck was moved backward away from the gondola to impart load in the flight train and to slow the lift-off. As suspension lines became tight, the gondola was rolled on its cart about 75 to 100 feet and lifted off the cart and then set down gently on the ground. As the gondola began to lift, the anchor truck was signaled to start forward toward the magnet. The magnet was about 20 feet in the air with the balloon leaning over at about 60°. Up to this point the launch was proceeding well considering the cross wind.

With the gondola about 20 feet above the ground, the anchor line was prematurely fired allowing the gondola to swing down and strike the ground and start dragging. In an effort to prevent damage to the gondola, the electronics engineer called to an electronics technician to fire the balloon loose. Before the technician could fire the balloon away, the magnet was clear of the ground and apparently still operating. As the balloon ascended to approximately 200 feet, it was terminated. Due to the low altitude, the parachute did not have sufficient time to deploy, allowing the magnet to free fall.

The magnet landed quite squarely on its base and than fell over. Until the magnet fell over, it was still operating. The magnet sustained considerable external damage to the cooling jacket and support framework. The extent of internal damage, if any, could not be determined without extensive disassembly, which was not possible in the field.

RAVEN®
industries, inc.

Weeks later, in the Goddard Laboratory, the magnet underwent a thorough inspection and was found to be in reasonable sound condition and would be rebuilt in time for the 1973 Program.

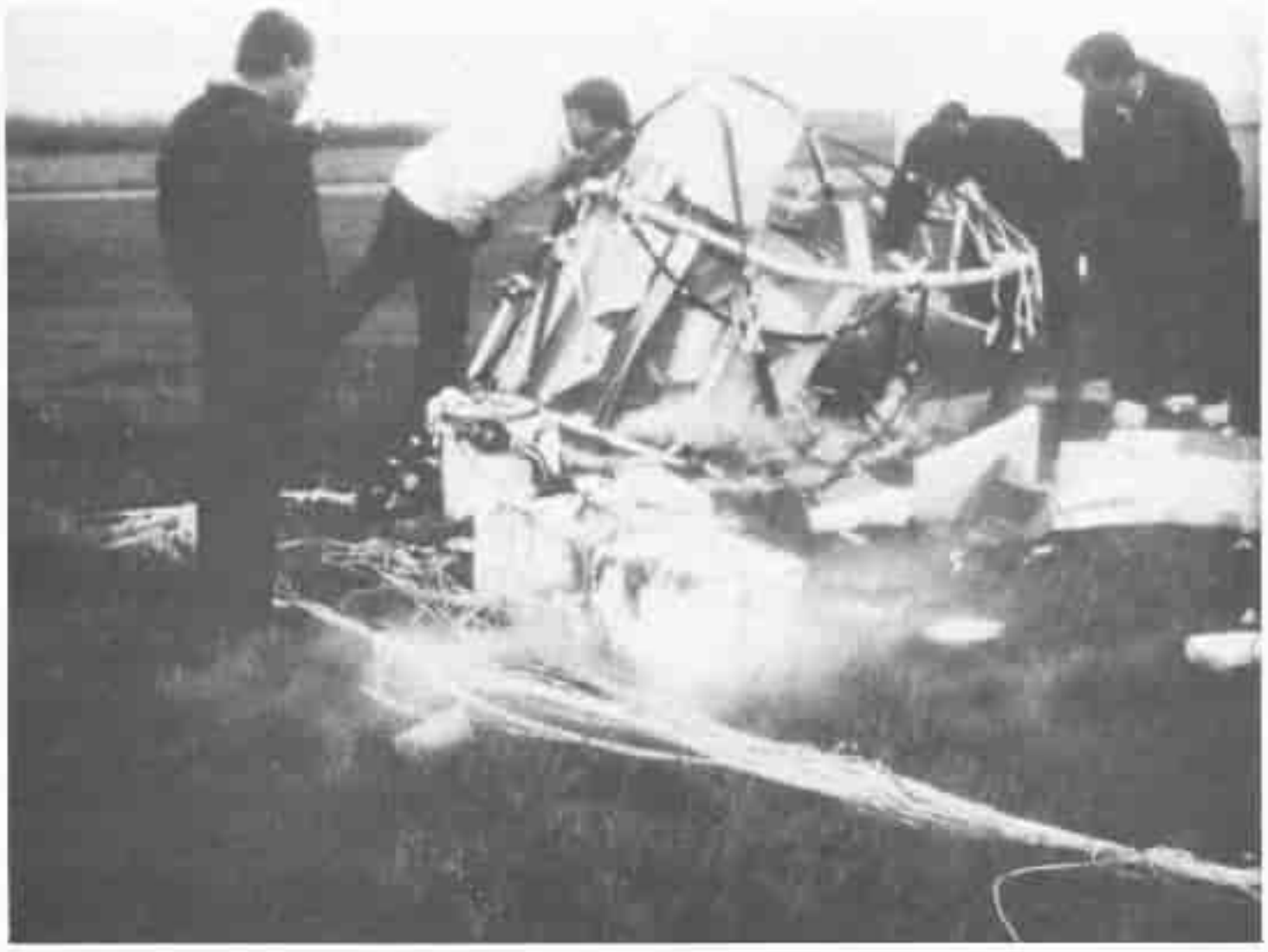
Flight train configuration on future flights will include a ballast system built into the gondola frame, reducing the length of the gondola for a truck launch. The launch frame on the truck to be constructed of aluminum or non-magnetic stainless steel.

Events of this ill-fated launch points out serious personnel problems. Certain personnel are normally placed in key positions during the launch. Three such positions existed on this launch: (1) the director who positions and briefs everyone moments before launch and who is positioned near the gondola to direct its movement as required, (2) the driver of the anchor truck who moves only as directed by the launch director, and (3) the man on the anchor line firing box who is always an experienced launch technician who knows the parameters under which a safe launch may be performed.

Some communication control was lost since the launch took place over a rather large area which separated the director from the man on the anchor line and other launch personnel who took it upon themselves to issue directions to subordinates.

Responsibility for terminating the flight lies with the director. This has been the policy for the Raven launch crew for the past ten years.

This was the only instance of an unauthorized termination in Raven's history.



In surveying the launch area, it was discovered that on the first contact with the ground the scientific telemetry package had been knocked off. This in itself would not have affected the success of the experiment.

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1342 Director Fulkerson
2. Scientist Reams Group GSFC Date/Time 10-20-72/ 1355 Z
3. Launch: Site Red Deer, Canada Technique/Launch Veh. Anchor Line
4. Wx: 90 @ 31°F 335° 5 MPH SLP-1014.6 Cross Wind Angle 70°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. --- ft. Temp --- °C Inflation Start 1300 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 650 ft.

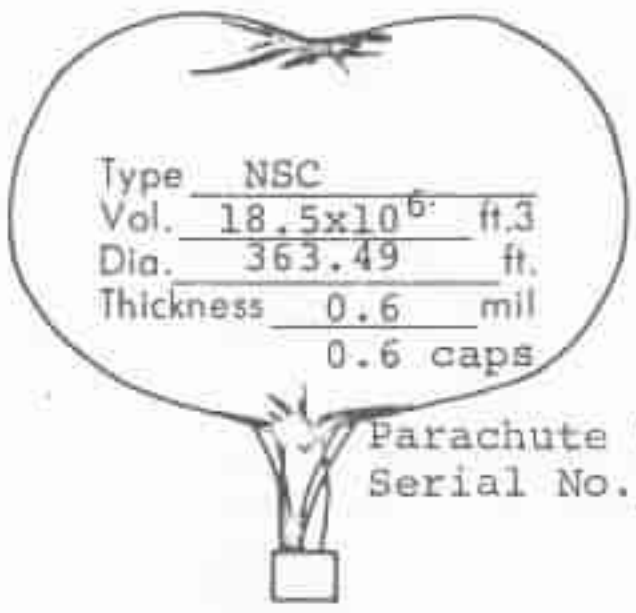
5. Balloon: Theoretical 3.02 - 2.85 Mbs. 134.4 - 135.8K ft. How Determined? MFG Curve

Ceiling: Actual --- Mbs. --- ft ---

6. Ascent: Surfact to Trop. --- fpm Trop. to Ceiling --- fpm
7. Flight Duration: Total -- hrs. -- min. At Ceiling -- hrs. -- min.
8. Termination: Time 1357 Z Altitude 300 ft. Cause R/C
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 10-20-72/ 1357 Z Location Red Deer Industrial Airport
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
248.6	Telemetry	2.0
149.4	Communications & Command	2.0

12. Balloon: Code Number SF 363.49-060-NSC-02 Serial Number 8



WEIGHTS

Balloon	1,877
Parachute	75
Instrumentation Raven	80
Ballast & Rigging	276
Scientific Package	1,192
Other Timers	15
Other Crush Pad	10
Gross Weight	3,525
Free Lift 14%	494
Gross Inflation	4,019
Helium used (cu. ft.)	62,294

13. Flight Failures Launch abort.
(Nature of flight failures - if any)

14. Comments
(Significant factors concerning the operation)

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1343 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
31 October 1972
Dr. R.C. Hartman

The second experiment, the NASA-Goddard $E^{\pm}$ Instrument, was a magnetic spectrometer designed to measure the energy spectra of cosmic-ray positron and electrons. Events are initiated by a particle telescope consisting of several plastic scintillation counters and a Cerenkov counter. Particle trajectories are measured with digital wire spark chambers using magnetic core readout. The high energy version flown from Red Deer contained a 2500 pound permanent magnet with a central field of 10 kilogauss and a field integral of 22 Kg/cm leading to an energy range of 250 - 20,000 MeV.

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industries, inc.

The total weight of the gondola was 3,866 pounds, which made it one of the heaviest experiments flown by Raven. The experiment was much too large to fly from Fort Churchill, exceeding the capabilities of the launch equipment, as well as the capacity of the recovery helicopter. For this reason, Red Deer was selected as a suitable launch site.

Upper winds indicated a trajectory would extend east southeast from Red Deer. Wind velocities varied from day to day and an eight to twelve hour flight would land around the Winnipeg area.

A down wind telemetry and tracking station was located at Dauphin, Manitoba, which was about 180 miles northwest of Winnipeg.

The instrument arrived at Red Deer partially disassembled and had to be finished in the field. Final assembly and checkout required about ten days.

Weather conditions looked favorable on October 25, so the launch crane was brought to the airport by the contractor. The special pin fitting was attached and the gondola weighed and suspended with final rigging and adjusting. The rigging took several hours. The surface wind began to pick up so the launch was cancelled. The dry run was beneficial to both scientist and launch crew. Many time-consuming rigging problems were simplified, and the launch pin was adjusted to eliminate some of the sharp edges.

On 27 October, the launch was rescheduled. With little or no delay, the crane was set up and the gondola was suspended and on its way to the launch site.

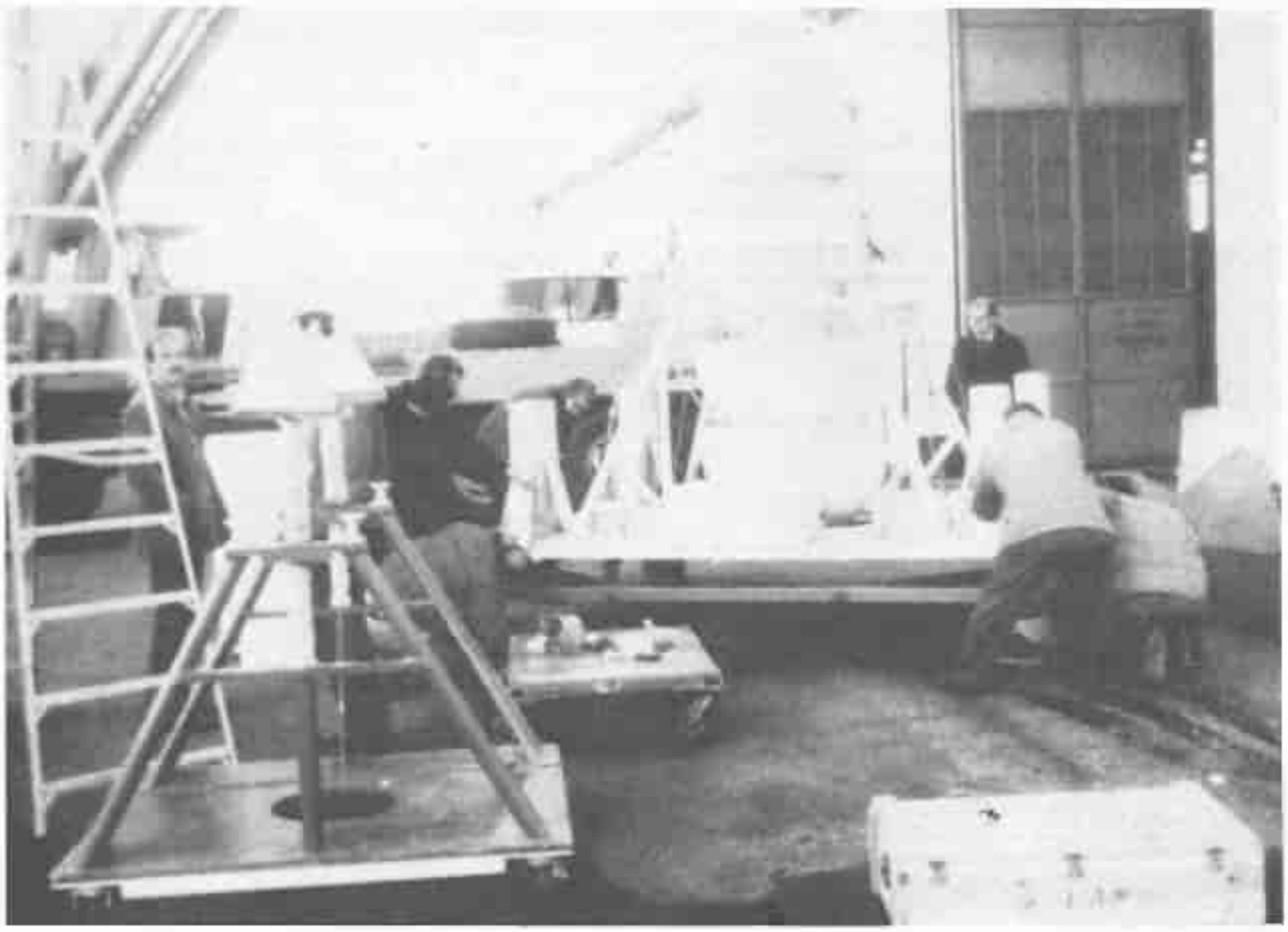
Inflation from the large Bu-Mines trailers was complete in less than 35 minutes. The launch was conducted in a six mph wind of about 6° to 10° across the flight train. The launch proceeded normally, with the crane moving ahead slowly to keep the flight train tight. Movement of the crane was not timely, allowing the balloon to reach vertical position with slight slack in the flight train. As the crane moved into position to release the gondola, the balloon split open and settled on the runway.

The gondola was not subjected to any abuse and was returned to the hangar.

The balloon was a Winzen 10.6 MCF, with a 1.5 mil cap weighing 2,894 pounds. The balloon was manufactured on September 21, 1971. Prior to January 25, 1972, all balloons were folded with one gore folded around the balloon. It is believed by some users of Winzen balloons that this method of folding or the reefing sleeve, or a combination of both, caused numerous balloon failures.

Since 1969, 83 ONR SKYHOOK flights were equipped with the reefing sleeve. Sixty were folded the same as the balloon on Flight 1343. During this period, no flight failures occurred which could be definitely attributed to folding or the reefing sleeve. Prior to 1969, over 117 balloons were flown which were folded the same way as Flight 1343 with no failures.

The balloon was inspected and the suspect gore was intact. The flight was not rescheduled until helium arrived on the 29th.



SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1343 Director Fulkerson
2. Scientist Hartman Group GSFC Date/Time 10-27-72 / 0702 Z
3. Launch: Site Red Deer, Canada Technique/Launch Veh. Dynamic - Crane
4. Wx: 30 Φ 17°F 160° 6 MPH Cross Wind Angle 10°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. --- ft. Temp --- °C Inflation Start 0600 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 600 ft.

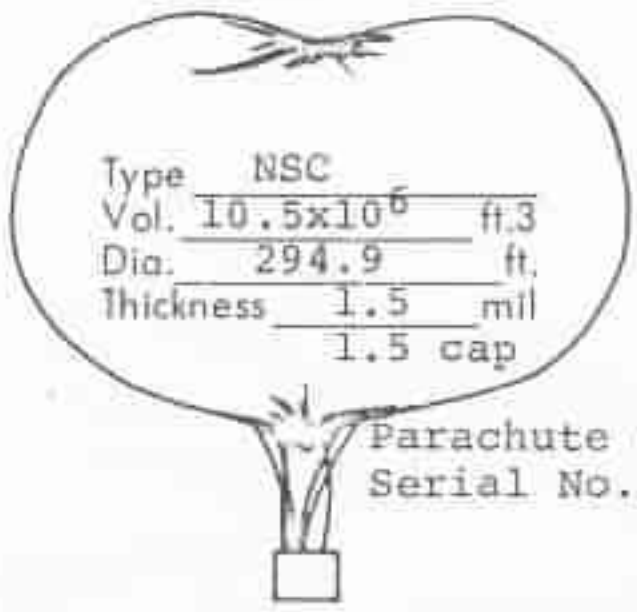
5. Balloon: Theoretical --- Mbs. --- ft. How Determined?

Ceiling: Actual --- Mbs. --- ft ---

6. Ascent: Surfact to Trop. --- fpm Trop. to Ceiling --- fpm
7. Flight Duration: Total -- hrs. -- min. At Ceiling -- hrs. -- min.
8. Termination: Time 1703 Z Altitude --- ft. Cause ---
9. Balloon Destruction-Confirmed ---- (visual, unknown, etc.)
10. Impact: Date/Time -- / -- Z Location Launch Site
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	2.0
149.4	Communications & Command	2.0

12. Balloon: Code Number SF 294.9-150-NSC-03 Serial Number 5



WEIGHTS

Balloon	2,925
Parachute & Rigging	250
Timer&Instrumentation Raven	64
Ballast	600
Scientific Package	3,866
Other Crush Pad	68
Other	
Gross Weight	7,773
Free Lift 12%	933
Gross Inflation	8,706
Helium used (cu. ft.)	134,943

13. Flight Failures Balloon split after release and before lift off.
(Nature of flight failures - if any)

14. Comments
(Significant factors concerning the operation)

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1344 - FLIGHT DESCRIPTION

NASA-GODDARD SPACE FLIGHT CENTER
31 October 1972
Dr. R. Hartman

Weather conditions looked favorable on the 30th, so the launch crane was rigged and the NASA gondola was suspended and made ready for launch.

The launch crew attaching the launch pin and retention lines.

Surface winds shifted to an unfavorable direction and increased in velocity to twelve mph. After several hourly delays, the flight was rescheduled for the following day.

The flight train was exactly like the previous flight, with the exception of the balloon. As a precaution against having the reefing sleeve cause possible damage to the balloon, the reefing sleeve was opened for about 100 feet and the balloon gore, to which the sleeve was attached, was folded back over the balloon, placing all the seals and load tapes on one side.

In view of all the extra preparation, the flight was ready for launch in just over an hour. A slight cross wind during launch made it necessary to move the crane about 800 feet for a perfect lift off.

The balloon ascended at 700 fpm to the tropopause and about 500 fpm into ceiling. The initial trajectory was to the southeast for the first few hours and gradually turned to the south.

Balloon control instrumentation and scientific equipment were working very well through the first six hours of flight. Than the NASA data telemetry signal became intermittent. At 2200Z, the signal was too weak to be of any value so NASA scientist suggested the recovery crew terminate the flight as soon as practical. Termination was affected thirty minutes later. During descent at approximately 10,000 feet, the recovery aircraft made a close pass and noted the parachute had one complete gore ripped open with numerous small rips throughout the rest of the canopy.

The gondola landed gently in an area of rolling prairies where it was recovered and loaded on a truck and taken to town and placed in storage till ready for return shipment to Goddard.

The parachute used for this flight was one provided by the Office of Naval Research. The parachute was described as having a "reinforce canopy." During rigging, the parachute was thoroughly examined and found to be similar to the 100 foot parachute flown on Flight 1341. Both parachutes had consecutive serial numbers and manufacture dates. The reinforcement was apparently in the suspension lines which were rated at 750 pound instead of the original 550 pounds. One gore had an "L" shaped tear approximately eight to ten inches on a side near the skirt.

Post-flight examination of the parachute disclosed considerable damage to 28 gores. Hole sizes ranged from 1-1/2 to 18 inches with No. 42 gore ripped from the skirt to the vent. An area between three gores showed evidence of heat sufficient to melt the canopy material.

Since the damage to the parachute reduced its area by only 3.5%, the landing velocity was adequate to prevent damage to the gondola. It is believed the flight narrowly escaped being a free fall.

In an effort to eliminate the possibility of future parachute failures, all flights involving heavy loads and large parachutes have been analyzed and compared, the results of which are included under the section "Parachute Analysis."

SKYHOOK BALLOON FLIGHT INFORMATION
NAVEXOS 3900/2 (Rev. 8-66)

RAVEN industries, inc.

1. Company Raven Ind. Inc. Flight Number 1344 Director Fulkerson
2. Scientist Hartman Group GSFC Date/Time 10-31-72/ 1427 Z
3. Launch: Site Red Deer, Canada Technique/Launch Veh. Dynamic - Crane
4. Wx: 90 Ø 250 Ø 25°F 170° 6 MPH Cross Wind Angle 20°
(Sky-Temp-Wind-Pressure)

Trop (Coldest) Ht. 39,000 ft. Temp --- °C Inflation Start 1320 Z

Hrs. Sunshine on Bubble --- Train Length (Layout) 600 ft.

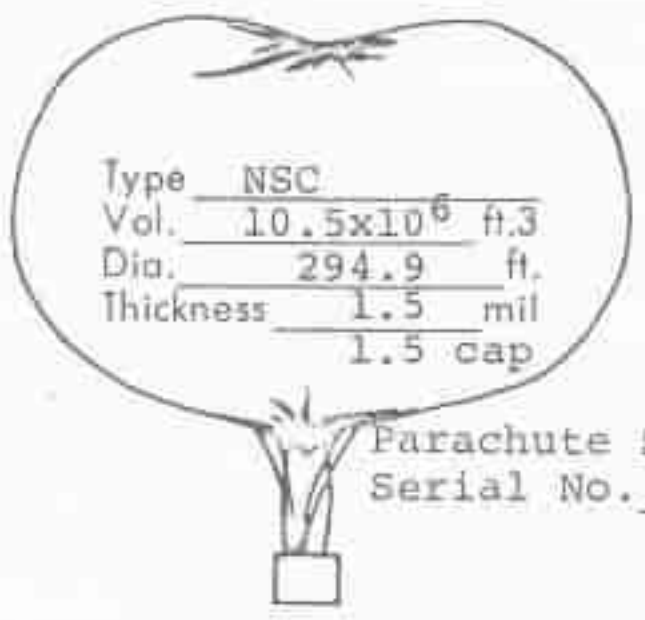
5. Balloon: Theoretical 9.8 - 9.3 Mbs. 105.5 - 106.8 K ft. How Determined? MFG Curve

Ceiling: Actual 9.55 Mbs. 106.0 K ft Transducer

6. Ascent: Surfact to Trop. 709 fpm Trop. to Ceiling 496 fpm
7. Flight Duration: Total 8 hrs. 22 min. At Ceiling 4 hrs. 53 min.
8. Termination: Time 2220 Z Altitude 106.0 K ft. Cause R/C - C-47
9. Balloon Destruction-Confirmed Visual (visual, unknown, etc.)
10. Impact: Date/Time 10-31-72/ 2249 Z Location 111° 34' W 48° 12' N
15 miles east of Conrad, Montana
11. Frequency used:

(MHz, KHz)	Purpose	Total Time
256.2	Telemetry	10.0
149.4	Communications & Command	10.0

12. Balloon: Code Number SF 294.9-150-NSC-03 Serial Number 4



WEIGHTS

Balloon	2,894
Parachute & Ladder	250
Instrumentation Raven	70
Ballast	400
Scientific Package	3,866
Other Crush Pad	68
Other	
Gross Weight	7,548
Free Lift 10%	755
Gross Inflation	8,303
Helium used (cu. ft.)	128,696

13. Flight Failures
(Nature of flight failures - if any)

14. Comments
(Significant factors concerning the operation)

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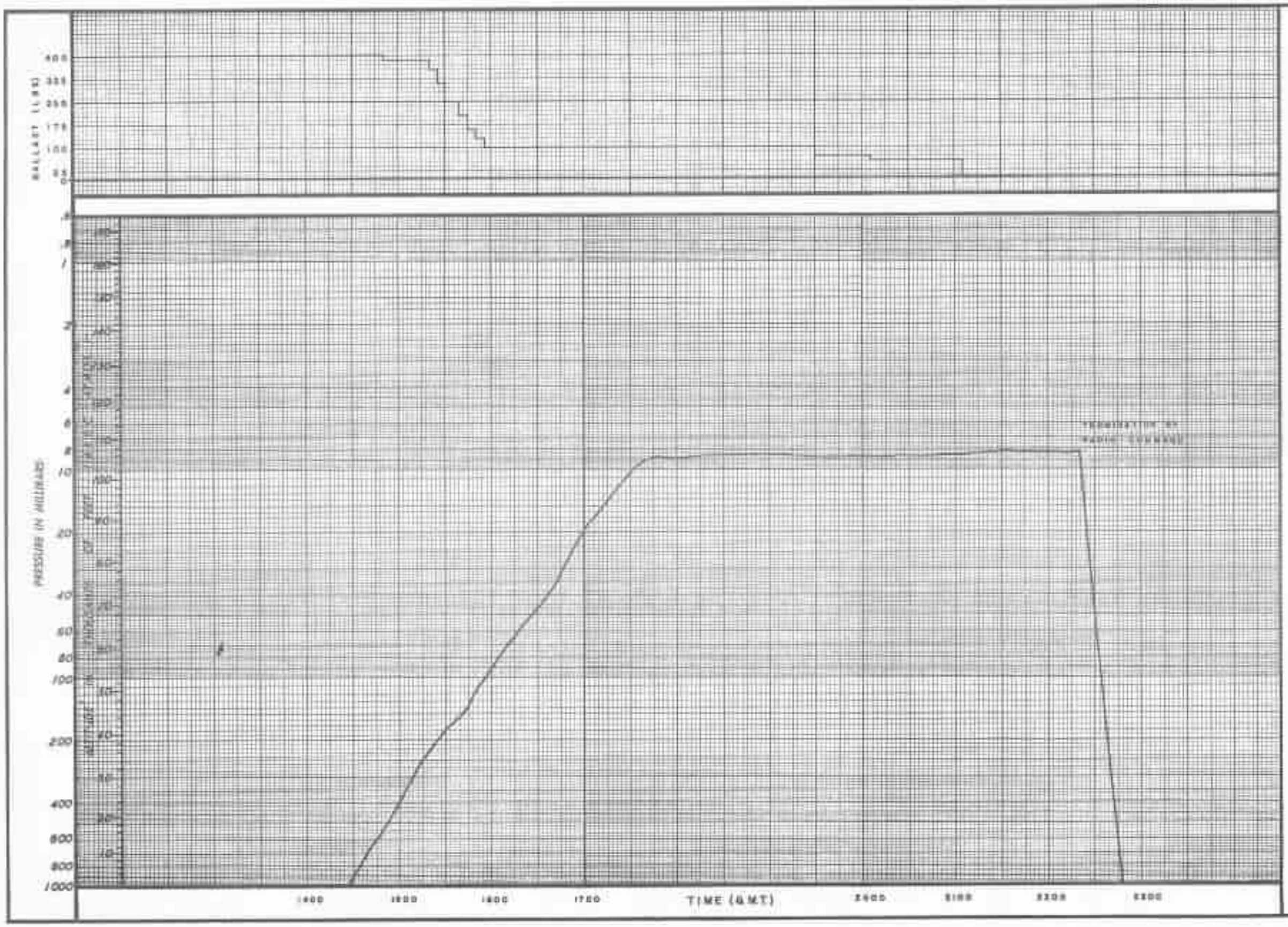

FLIGHT NO. 1344

DATE: 10-31-72

FOR: GSFC

BALLOON

TYPE: NSC

VOL: 10.5×10^6 FT.^{3}

MAT: 1.5 MIL/1.5 CA

WT: 2894

LOAD FACTORS

PAYLOAD: 4654

GROSS LD: 7548

FREE LIFT: 755

BALLAST: 400

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DR.

CHK.

APPR.

RAVEN industries, inc.

IV. PARACHUTE FAILURE ANALYSIS

The parachute, when incorporated into a balloon flight train, is generally extended and becomes a structural member of the flight train connecting the balloon to the experiment. In this configuration the parachute is under tension during inflation, launch, and throughout the flight.

Parachute rigging will vary depending on experiment configuration, launch equipment, or launch technique. During the 1972 Skyhook Program, all parachutes were incorporated into the flight train in the same manner. Some flights, however, had extension lines between the experiment and confluence point of the parachute to facilitate launching from cranes.

The parachute is attached to the balloon with a triple wrap of 10,000 pound test nylon and an aluminum load link which provides the proper radius for the nylon release and parachute suspension lines. Two double squib cannons and a six-second delay squib comprise the hardware compliment on top of the canopy. All of these items remain with the canopy after separation from the balloon.

Two four-wire electrical cables attached 180° apart on the canopy and down the suspension lines provide power for firing termination squib cannons.

The end of the parachute suspension lines or risers are separated by a spreader bar of approximately 18 inches in length. The bar helps minimize twisting and assists parachute opening.

When the flight train is released from the balloon, the tension in the parachute suspension lines accelerates the canopy section toward the experiment gondola. This acceleration, normally called "rebound" or "sling shot affect" varies between flights depending on construction of the parachute, altitude, and load on the parachute. Rebound is believed to be the primary factor in the parachute failures during this year's program.

Parachute selection is primarily based on the desired velocity at landing. Normally, impact velocities are

kept between 18 FPS and 25 FPS. In some cases, a compromise is made by using a lighter weight parachute to gain altitude, resulting in a faster descent rate.

The parachute failure of Flight 1339 points out the marginality of parachute selection based on terminal velocity alone. The parachute on this flight was a 64-foot flat circular canopy with 64 suspension lines. The weight of the parachute when fully rigged for flight was 67 pounds which made it ideal for experiments in the 600 to 1000 pound range where it was satisfactorily used on many flights.

Size wise, this parachute was sufficient. The suspension lines were 300 pound test nylon with an elongation of 30%. At the time of termination, each line was loaded to .08% of its rated strength.

At this time, it appears that acceleration caused by an .08% load was enough to cause parachute contact with the gondola. Owing to the close couple of the gondola and parachute, the canopy and suspension lines contacted the gondola and due to the many protrusions on the gondola became permanently entangled. A portion of the rip panel line was still attached to the parachute; being entangled during the six to eight seconds required for the delay squib to release.

Hardware items on the parachute canopy indicated some damage to the canopy was actually caused by protrusions of the cannon plugs and load link. It is believed the hardware attributed less to initial fouling, but impeded recovery by snagging the canopy and suspension lines.

A second flight, 1344, sustained serious parachute damage but managed to recover and descend normally.

Since the two flights present two occasions when parachute problems existed, we can make an assumption that the two systems were sufficiently similar to incurred problems, while being sufficiently different to allow one flight to recover.

The following Table compares Flights 1339 & 1344 with other flights this year:

TABLE

Flt. No.	Load (lbs)	No. Lines	Dia. (feet)	Line Test (lbs)	% Load	FPS Velocity	Separation (feet)	Parachute Length (feet)	Altitude
1339	1604	64	64	300	.083	23.5	8	88	124
1344	4254	108	100	750	.052	25.0	68	130	106
*1320	2816	72	84	550	.071	24.0	50	123	122
1338	1889	52	67	550	.066	24	50	90	119
1340	1898	52	67	550	.066	24.5	50	88	115
1341	2932	108	100	550	.049	20	50	123.5	130

*Parachute has Ring-Sail canopy

The damage to the parachute on Flight 1344 was caused by the canopy coming into contact with the 68-foot cable suspension, which was fitted with several spacer bars to prevent twisting. The ends of the bars extended one inch beyond the cable, providing a protrusion every ten feet on each cable. Small bits of parachute canopy were found on the cable.

Flight 1320, using a 84.2-foot diameter Ring-Sail Parachute, constructed with 72 suspension lines had a loading of .07%. The rebound during termination was minimized by several factors. First, the ten pound Back-Up Timer, peculiar to this flight, was ripped off and secondly, the 10,000 pound nylon line had to slide through one of the squib cannons for a distance of approximately 28 inches. The canopy was also of light weight construction. Damage to the gondola was attributed to a combination of the 24 FPS terminal velocity and structural design.

Of the twenty other flights flown during 1972, all had a parachute loading of less than 4%.

On future flights, parachute selection will be based on parachute loading of 5% maximum and a terminal velocity of no more than 20 FPS. The separation between gondola and parachute will be increased on the heavier loads, with emphasis on eliminating protrusions.

Hardware items atop the parachute are to be modified to minimize weight and possible protrusions which may cause snagging.

Old and new cannon assembly showing an effort to cut down on all sharp edges.

When the diameter of a parachute is acceptable for a given load but construction is marginal, a center load line which carries 90% of the load will be used.

In some instances it may be possible to descend the balloon by valving to an altitude where the parachute will deploy quickly when separated from the balloon. Valving to lower levels may be more applicable to flights during wind reversal when trajectories are normally short. Valving during the Churchill Series would minimize flight duration; more especially with the large balloons.

New parachutes being procured through the Office of Naval Research will incorporate materials of low elongation to minimize rebound effects.

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13. ABSTRACT

Contract N00014-72-C-0400 was awarded to Raven Industries, Inc. on 3 April 1972. The program was funded to conduct balloon field operations from Fort Churchill, Manitoba, Cape Girardeau, Missouri, and Red Deer, Alberta. Raven provided a field crew, suspension and rigging hardware, aircraft and helicopter tracking, parachutes, balloon telemetry and control instrumentation, electronic tracking, and reports and documentation as necessary. This report describes individual flights, equipment used, flight data, and various program information.

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